BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE MANUAL 11-2T-38A-B

20 APRIL 2022

Flying Operations

T-38A/B FLYING FUNDAMENTALS

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

ACCESSIBILITY: This publication is available for downloading or ordering on the e-Publishing website at www.e-Publishing.af.mil

RELEASABILITY: There are no releasability restrictions on this publication.

OPR: ACC/A3TO

Certified by: AF/A3T
(Maj Gen Albert G. Miller)

Pages: 150

This publication implements Air Force Instruction (AFI) 11-200, *Aircrew Training, Standardization/Evaluation, and General Operations Structure*. It provides a comprehensive document containing T-38A/B fundamental procedures and techniques that may be used to accomplish the various missions of the T-38A/B. This publication applies to Regular Air Force, Air Force Reserve Command, and the Air National Guard. This publication does not apply to the United States Space Force. Ensure that all records generated as a result of processes prescribed in this publication adhere to AFI 33-322, *Records Management and Information Governance Program*, and are disposed of in accordance with (IAW) the Air Force Records Disposition Schedule which is located in the Air Force Records Information Management System. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the DAF Form 847, *Recommendation for Change of Publication*; route DAF Forms 847 from the field through the appropriate functional chain of command. This publication may be supplemented at any level, but all supplements must be routed to the OPR of this publication for coordination prior to certification and approval. The authorities to waive wing/unit level requirements in this publication are identified with a Tier ("T-0, T-1, T-2, T-3") number following the compliance statement. See Department of the Air Force Manual (DAFMAN) 90-161, *Publishing Processes and Procedures*, for a description of the authorities associated with the Tier numbers. Submit requests for waivers through the chain of command to the appropriate Tier waiver approval authority, or alternately, to the publication OPR for non-tiered compliance items.

Chapter 1

OVERVIEW/BACKGROUND

1.1. Overview. This publication addresses basic flying tasks and planning considerations. It is designed to be used in conjunction with Air Force Manual (AFMAN) 11-2T-38, Volume 1, *T-38 Aircrew Training;* AFMAN 11-2T-38, Volume 2, *T-38 Aircrew Evaluation Criteria;* AFMAN 11-2T-38,Volume 3, *T-38 Operations Procedures,* Technical Order (TO) 1T-38A-1, *Flight Manual USAF Series T-38 Aircraft;* and appropriate training syllabi. **Note:** Hereafter in this publication, *Flight Manual USAF Series T-38 Aircraft* TO 1T-38A-1, will be referred to as "the flight manual."

1.2. Background. It presents a solid foundation on which initial qualification, instrument proficiency, and continuation training can be maintained. It is not designed to be used as a step-by-step checklist of how to successfully employ the T-38A/B, but to provide information and guidelines on basic procedures and techniques.

Chapter 2

ROLES AND RESPONSIBILITIES

2.1. Commanders. Commanders and their respective tier levels are responsible for complying with guidance in this manual. **(T-1)** T-38A-B flying unit wing commanders, delegated no lower than the operations group commander (or equivalent), are responsible for providing local operating guidance to supplement the requirements of this manual. **(T-2)**

2.2. Pilot in Command (PIC). The PIC is ultimately responsible for the safe and effective operation of the aircraft. **(T-2)** PICs for all flights are designated on a flight authorization form, or equivalent, IAW DAFMAN 11-401, *Aviation Management*. PICs are:

2.2.1. In command of all persons aboard the aircraft and vested with the authority necessary to manage their crew and accomplish the mission. **(T-2)**

2.2.2. Responsible for the welfare of the crew and the safe accomplishment of the mission. **(T-2)** This begins upon notification of the mission and terminates upon completion of the debrief. If the PIC determines that conditions are not safe to prosecute the mission, the aircraft will not depart until the condition is adequately mitigated. **(T-2)**

2.2.3. The final mission authority and will make decisions not specifically assigned to higher authority. **(T-2)**

2.2.4. Charged with keeping the applicable commander informed concerning mission progress and difficulties. **(T-2)**

2.2.5. The final authority for asking and accepting waivers affecting the crew or mission. **(T-2)**

2.3. Mission Preparation.

2.3.1. Objectives. Preparation for any mission should be based on objectives. The overall mission objective should give the “big picture” of what needs to happen to accomplish a successful sortie. More specific objectives should be used to determine success in relation to syllabus, course training standards, continuation training requirements, etc. A valid objective is realistic, achievable, and measurable; and it has three stated or implied parts—performance, conditions, and standards, as follows:

2.3.1.1. Performance. This indicates what each flight member is required to do during the mission. It describes action and is specific; for example, practice a no-flap landing, demonstrate proficiency on a loop.

2.3.1.2. Conditions. These are the starting parameters; for example, begin the loop with military power (MIL) and 500 knots indicated airspeed (KIAS).

2.3.1.3. Standards. These are required parameters to meet in accomplishing the maneuver as briefed by the aircraft commander (AC) or lead.

2.4. Mission Briefing.

2.4.1. As a minimum, the briefing guides in the appropriate volume of the AFMAN 11-2T-38 series will be used and discussions on formal special interest items (SII) will be included. Other members of the flight or formation should be prepared for the briefing and assist the AC or lead as directed. The briefing should focus on successfully accomplishing the objectives.

2.4.2. Mission elements may be briefed as “standard” if they are published and the proficiency level of all flight members would allow them to be briefed as such.

2.5. Debrief. The main goal of the debrief is to determine if the briefed mission objectives were achieved and to what level. From both administrative and tactical perspectives, the instructor pilot (IP), AC, and/or lead should cover what went right, what went wrong, the root cause of any errors, and how to improve subsequent missions. All questions, concerns, and disagreements should be addressed. Debrief by objective, examining how well each objective was achieved. At the end of the debrief, summarize with emphasis on the basics, the major learning points, and considerations for future missions.

Chapter 3

START, TAXI, TAKEOFF, CLIMB, AND LEVELOFF

3.1. Checklist Discipline. Ensure completion of all items IAW the applicable flight crew checklist. You do not have to reference the checklist to complete each individual item. You may accomplish a few items and then refer to the checklist to ensure completion of all items. The pilot at the controls should initiate all checks and ensure the asterisked items are accomplished in both cockpits, if applicable.

3.2. Preflight:

3.2.1. Review and Walkaround. Ensure the Air Force Technical Order (AFTO) Forms 781, *ARMS Aircrew/Mission Flight Data Document*, are complete, correct, and the aircraft is airworthy. Perform a walkaround IAW -1CL. If any doubt exists as to the condition, setting, or operation of any system, consult a qualified maintenance representative. The pilot in command is the final authority on the airworthiness of the aircraft.

3.2.2. Ground Visual Signals. Keep hands clear any time someone is under the aircraft. The crew chief is the safety observer. Monitor the crew chief's signals closely for safety actions. Perform all visual signals IAW AFMAN 11-218, *Aircraft Operations and Movement on the Ground.*

3.2.3. Foreign Object Damage (FOD) Avoidance. To reduce the risk of FOD during ground operations, do not place objects on the cockpit glare shields while the engines are running unless the canopies are down and locked. In addition, do not allow personnel to climb on the aircraft with either engine operating and do not hand objects over the cockpit side unless the engine on that side is shut down and has stopped rotating.

3.2.4. Taxi Operations:

3.2.4.1. Clear in all directions before advancing the throttles. Keep the use of power to a minimum. Normally, a power setting less than 80 percent revolutions per minute (rpm) should be enough to taxi. Check the nosewheel steering and brakes as you taxi out of the spot.

3.2.4.2. Reduce throttles to IDLE for all turns to avoid jet blast damage to ground equipment, aircraft, and personnel. Check the flight instruments in a non-congested area. Taxi at a moderate speed and stagger only in non-congested authorized areas.

3.2.4.3. Use the brakes sparingly with throttles in idle to prevent wear and overheating. Adjust taxi speeds during high or gusty wind conditions to prevent exceeding the 50-knot canopy limit. When opening the canopy in high or gusty winds, hold the canopy frame to prevent rapid flyup.

3.2.4.4. When taxiing closely behind aircraft with engines running, lower the canopies to prevent exhaust windblast effects. **(T-3)** Do not taxi within 10 feet of any obstacle. **(T-3)** Do not taxi within 25 feet of an obstacle without a wingwalker. **(T-3)**

3.2.5. Instrument Cockpit Checks. Pilots will complete the instrument cockpit checks on every mission. They should check the following:

3.2.5.1. Heading System. Ensure the horizontal situation indicator (HSI) is within 8 degrees of the magnetic compass and within 5 degrees of a known heading.

3.2.5.2. Attitude System. Set the main and standby attitude director indicators (ADI) at 3-degree nose-low. This setting will approximate the level-flight indication for intermediate leveloffs and normal cruise conditions.

3.2.5.3. Bank Steering Bar Check. Accomplish this check as follows:

3.2.5.3.1. Navigation mode switch—TACAN.

3.2.5.3.2. Steering mode switch—NORMAL. (The pitch and bank steering bars should not be in view.)

3.2.5.3.3. Steering mode switch—MANUAL. (Bank steering bars should be in view.)

3.2.5.3.4. Heading marker—put the heading set marker on the upper lubber line of the HSI. The steering bar should center. Rotate the heading set knob and ensure the bank steering bar indicates a right or left turn, as appropriate.

3.2.5.3.5. Steering mode switch—NORMAL. (The bank steering bar should be out of view.)

3.2.5.4. Flight Director System—Instrument Landing System (ILS) Check. Accomplish the check as follows:

3.2.5.4.1. ILS frequency—tune and identify.

3.2.5.4.2. Course select window (CSW)—set the localizer final approach course.

3.2.5.4.3. Navigation mode switch—LOCALIZER. The course deviation indicator (CDI) and aircraft symbol should indicate the proper relative position to the localizer course. The bank steering bar should be in view and the localizer warning flag out of view. The glide slope indicator should be in view and the warning flag out of view. The glide slope warning flag may be in view, depending on the proximity to the glide slope transmitter.

3.2.5.4.4. Navigation mode switch—ILS. The CDI and aircraft symbol should indicate the proper relative position to the localizer course. The pitch and bank steering bars should be in view and the localizer warning flag out of view. The glide slope warning flag may be in view, depending on the proximity to the glide slope transmitter.

3.2.5.5. Flight Director System—Tactical Air Navigation (TACAN) Check. Accomplish this check as described below. The TACAN self-test described in the flight manual may replace this check if the station identifier is audible.

3.2.5.5.1. TACAN channel—tune and identify. Ensure the TACAN bearing to the station is within 4 degrees of the actual bearing.

3.2.5.5.2. CSW—center the CDI. Ensure the course in the CSW is within 4 degrees of the actual bearing to the station. With the CDI centered, rotate the course select knob until the CDI is displaced two dots to the right or left of center. Note the course in the CSW. This course should be 10 degrees greater or less than the original course plus or minus 1.5 degrees. Repeat this process in the opposite direction.

3.2.5.5.3. Ensure the range warning flag is out of view and the distance indicated is within 0.5 nautical miles (nm) or 3 percent of the distance to the facility, whichever is greater.

3.2.5.5.4. Check for a TO indication with the CDI centered. Rotate the course select knob past 90 degrees and check that the TO indication changes to a FROM indication.

3.3. End of Runway (EOR). Ensure all flight crew checklist items through "Before Takeoff" are complied with. Review takeoff procedures and details as well as how to handle serious emergency procedures immediately after takeoff. Check other aircraft for leaks, loose panels, proper configuration, streamers, FOD, etc. If able, make sure their elevator is properly trimmed for takeoff by inspecting the alignment marks.

3.4. Taking the Active Runway. Ensure the canopy is down and locked prior to engine runup. Release the nosewheel steering button during the last few degrees of turn onto the runway and momentarily displace the rudder pedals to ensure the nosewheel steering is disengaged. To ensure the nosewheel is centered, allow the aircraft to roll forward once it is aligned with the runway. Confirm your heading system is within tolerances.

3.5. Takeoff:

3.5.1. Static Takeoff:

3.5.1.1. Remind the other crewmember to guard the brakes, if applicable IAW -1CL. (When guarding the brakes, do not exert pedal pressure, but be in a position to immediately assume control.) Exert as much pedal pressure as necessary to prevent creeping during engine runup. Look outside the aircraft and advance the engines to MIL power. Your primary concern is to ensure the aircraft is not creeping forward or pulling to one side.

3.5.1.2. If the brakes do not hold at MIL power, reduce power and attempt to build sufficient hydraulic pressure by pumping the brakes. If the second attempt to keep the aircraft from rolling fails, consider aborting the aircraft. Once the lineup checks are complete, release the brakes; select maximum afterburner (MAX); confirm afterburner operation, ensuring the nozzles move into their proper MAX range—"two good swings"; and confirm exhaust gas temperature (EGT) readings stabilize within limits.

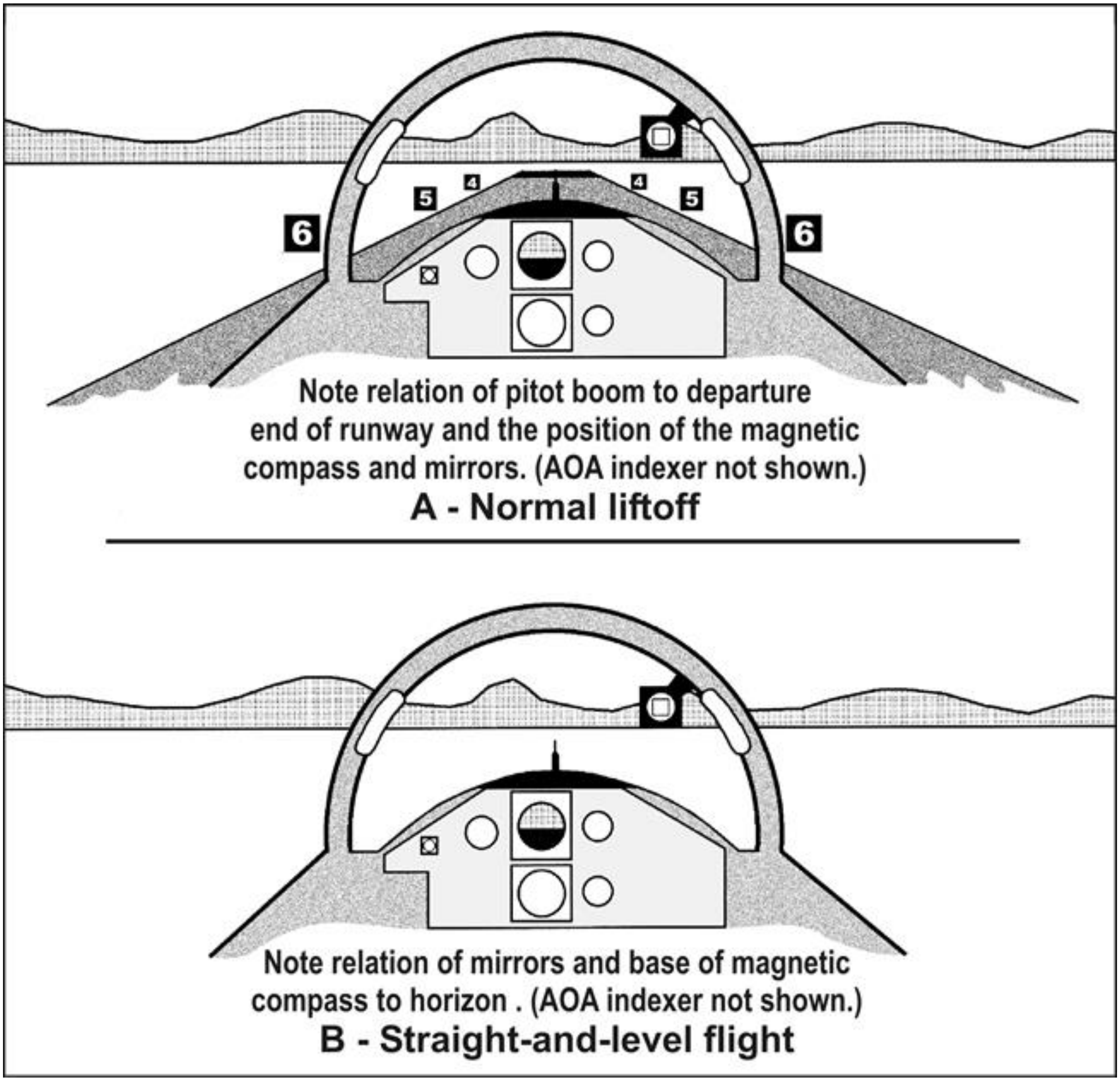
3.5.2. Rolling Takeoff. Ensure all lineup checks are complete prior to engine runup. Taxi onto the runway in a normal manner. After attaining proper runway alignment, check the heading system, disengage the nosewheel steering, and advance the throttles to MAX. During takeoff roll, confirm proper engine operation. You do not need to recalculate the takeoff and landing data (TOLD). Takeoff roll and critical field length increase approximately 150 to 300 feet.

3.6. Takeoff Roll:

3.6.1. Maintain directional control by tapping the brakes until the rudder becomes effective. Do not apply heavy pressure to either brake. Once the rudder is effective, drop your heels to the floor. This will ensure you do not inadvertently apply the brakes while using the rudder.

3.6.2. During the takeoff roll, check the minimum acceleration check speed (MACS) and remain aware of go/no-go speeds. At approximately 135 KIAS, smoothly initiate back stick pressure. Nose-wheel liftoff should occur at approximately 145 to 150 KIAS, and the aircraft should fly off the runway at approximately 160 KIAS. Use approximately 5 degrees nose-high for a rotation attitude (**Figure 3.1**) When safely airborne with a positive climb, retract the gear.

Figure 3.1. Representative Aircraft Attitude (Front Cockpit).



3.6.3. Following gear retraction, ensure sufficient airspeed exists before retracting wing flaps. Then check gear and flap indications to verify they are up. Be aware of more rapid acceleration on cold days and ensure that the flap and gear airspeed limits are not exceeded.

3.6.4. Whenever significant crosswinds are a factor, use aileron into the wind throughout the takeoff roll to prevent an early liftoff of the upwind wing and use rudder to maintain runway alignment. As airspeed increases, crosswind control inputs will decrease.

3.7. Climb. Climb IAW local procedures. If practical, use the restricted MIL climb schedule to maximize fuel economy.

3.7.1. Restricted MIL Climb:

3.7.1.1. Unless accomplishing a formation rejoin, begin a smooth power reduction out of MAX between 220 and 280 KIAS and terminate afterburner by 300 KIAS. Accelerate to and hold 300 KIAS (approximately 10 to 12 degrees nose-high) until passing 10,000 feet mean sea level (MSL).

3.7.1.2. After passing 10,000 feet MSL, accelerate in a shallow climb (approximately 1,000 to 2,000 feet per minute [fpm]) until reaching the cruise indicated Mach number (IMN) or airspeed IAW local procedures for the altitude you are cleared to. If you reach 400 KIAS before your cruise IMN, climb at 400 KIAS until reaching your cruise IMN. If assigned an intermediate leveloff, maintain the cruise IMN for the altitude assigned (.5 Mach + altitude in thousands/100) until assigned a higher altitude. At that time, accelerate to the higher cruise IMN.

3.7.2. Maximum Power Climb. In full afterburner, an attitude of approximately 20 to 25 degrees nose-high will hold 300 KIAS. Passing 10,000 feet MSL, lower the nose and accelerate to and maintain .9 IMN.

3.7.3. Climb Check. You may combine the climb check with the leveloff check when your cruise altitude is at or below flight level (FL) 180. Applicable steps of the climb check can be completed prior to 10,000 feet MSL, but the cabin altitude scheduling should be reconfirmed above 10,000 feet MSL.

3.8. Leveloff. The leveloff should be a smooth, continuous pitch change to level flight. Avoid abrupt pitch changes and stair-stepping to the desired altitude. Normally, a smooth leveloff is accomplished as follows: when vertical velocity indicator (VVI) is less than 6,000 fpm, begin the leveloff at 10 percent of the VVI; when VVI is greater than 6,000 fpm, reduce power and lower the nose to cut the picture in half about 1,000 feet prior in MIL power (or 2,000 feet prior in MAX power).

3.9. Cruise. Attain cruise airspeed, set the power, and trim the aircraft for level flight. To maintain level flight at medium or low altitude, set a fuel flow of approximately 1,100 pounds per hour per engine (pph/ engine) to maintain 300 KIAS. At or above FL350, consider flying at minimum of 0.9 Mach. For other altitude or airspeed combinations, set recommended fuel flows IAW the flight manual.

3.10. Abnormal Procedures:

3.10.1. Overview. To provide guidance for abnormal situations, information in this paragraph. includes procedures and techniques derived from years of experience and multiple sources. The intent is not to cover every situation you may encounter, to replace or supersede procedures in the flight manual, or to replace the use of sound judgment. Unusual or complex circumstances will require pilot judgment and systems knowledge to alleviate the situation.

3.10.2. Barrier Operations. The following barriers are suitable:

3.10.2.1. MA-1/MA-1A. The procedures for MA-1 or MA-1A engagement are specified in the flight manual. The minimum engagement speed is approximately 60 knots. Expect nose or main gear failure above 120 knots if aborting while heavy weight. The designed dynamic limit for the MA-1 and MA-1A is 150 knots for all aircraft. Cable failure will occur during attempted engagements above this speed. Engagement may not be successful so pilots must reapply brakes after an engagement attempt. Aircraft with a centerline pylon or store—or with the speed brakes open— may not successfully engage an MA-1 or MA-1A barrier.

3.10.2.2. BAK-15 (61QSII). The BAK-15 is a large web-type barrier that fighter-type aircraft have successfully engaged at speeds up to 200 knots. Successful engagement is completely independent of aircraft configuration. It is designed to be activated by tower personnel on command from the pilot and should be deployed within 5 to 7 seconds of activation. Pilots should be aware of the actual barrier position before arrival or departure**.** If aborting on a runway where the barrier is raised only on request, transmit “BARRIER, BARRIER, BARRIER.”

3.10.3. Ejection. If abandoning the aircraft becomes necessary, the AC will use the command “BAILOUT, BAILOUT, BAILOUT” as the final directive. If time and conditions permit, discuss and accomplish ejection procedures with the other crewmember, using the term “ejection” rather than “bail out.” Normally, the rear cockpit pilot will eject first. In critical situations, do not delay an ejection waiting for the “bail out” command and do not delay an ejection once the command is given.

3.10.4. Single Engine Taxi. Do not taxi the T-38 single engine. **(T-3)** You may, however, clear an active runway if you have downside hydraulics or your landing gear is pinned.

3.10.5. Change of Aircraft Control. Without intercom, transfer of aircraft control can result in disastrous crew confusion if not done in a positive, previously briefed manner. In all cases, transfer of aircraft control should follow procedures in AFMAN 11-2T-38, Volume 3. Normally, the AC will maintain control for the remainder of the flight, but some circumstances may necessitate a subsequent transfer of control. In these situations, the AC will yaw the aircraft to signal the transfer of aircraft control back to the other crewmember. The other crewmember will acknowledge by shaking the stick.

Chapter 4

TRAFFIC PATTERN AND LANDINGS

4.1. Introduction. High volume traffic patterns require diligent visual lookout and a complete knowledge of traffic pattern procedures. The flight manual describes the basic procedures for flying the T-38 in the traffic pattern and landing environment. From flight manual procedures, a variety of techniques can be used to safely and effectively land the aircraft. The rest of this chapter outlines the techniques most commonly used and taught in Pilot Instructor Training (PIT) and SUPT environments.

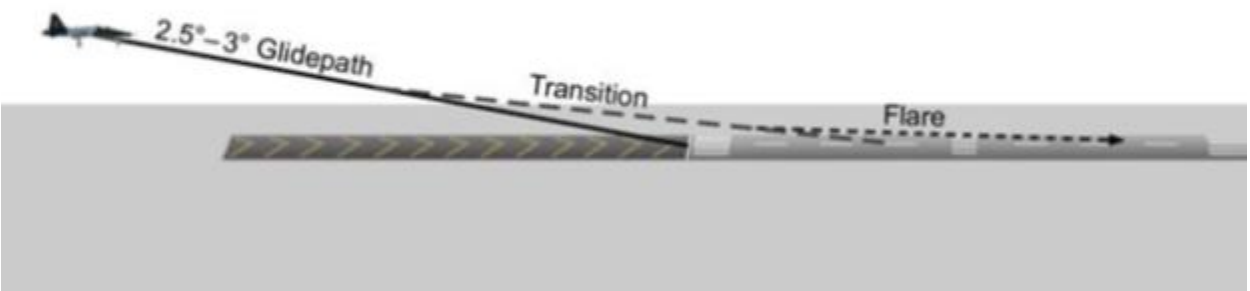
4.2. Judgment in the Traffic Pattern. Your judgment in determining whether an approach is safe must take airspeed, aircraft buffet, angle of attack (AOA) indications, and sink rate into account. When used together, these indicators can warn you of an approaching stall. Heavy buffet or a slow AOA indication in the traffic pattern may indicate one or more of the following conditions: an incorrect configuration, a miscalculated or poorly flown airspeed, an incorrectly set airspeed marker, too much back stick pressure, or an AOA or airspeed system malfunction. Low airspeed and/or high AOA may require a go-around. Also, erratic pitch changes can cause momentary flashing of the indexer lights.

4.2.1. **Warning:** More T-38 fatalities have occurred because of improperly flown final turns than for any other reason. If approach-to-stall indications or an excessive sink rate occurs in the traffic pattern, immediately execute a stall recovery. Do not attempt to maintain the traffic pattern ground track because the altitude needed for recovery may significantly increase.

4.3. Wind Analysis. Adjust all traffic patterns to compensate for known wind conditions. Use available wind information to attain adequate downwind displacement during and after the break or pulling closed. Compensate for winds on inside downwind by crabbing into the wind to maintain the desired ground track to the perch. With a strong headwind on initial, delay the break and begin the final turn earlier than for no-wind conditions. The opposite is true for significant tailwinds on initial.

4.4. General Approach and Landing Information. The basics for landing the T-38 involve flying down the glidepath at final approach speed based on a desired aimpoint. As the aircraft approaches landing, the glidepath aimpoint transitions to the flare where the aircraft is flared down to touchdown airspeed in ground effect (**Figure 4.1**)

Figure 4.1. Final Approach.



4.4.1. Glidepath:

4.4.1.1. The contact glidepath, above ground level (AGL) approximately 3 degrees, is defined off the desired aimpoint. A 3-degree glidepath positions the aircraft 300 feet at 1 NM from the selected aimpoint.

4.4.1.2. To select the aimpoint, a few factors must be considered. Most important, the desired touchdown point must be determined based on available runway and runway condition. The desired touchdown point may be altered in cases where prudence would dictate a slightly longer aimpoint, such as in runways where there are hazards in the overrun environment, no overrun, or raised lights at the threshold. Normally, the goal is to land 500 to 1,000 feet down the runway to allow the maximum runway available for the landing roll while offering a safe buffer from landing short. The normal touchdown point can be extended down the runway when conditions allow, for example, landing distance is not critical due to a long runway.

4.4.1.3. Generally, select an aimpoint 1,000 feet short of the desired touchdown point with the default being on the threshold. In situations where landing distance is critical, pilots may consider shifting the aimpoint slightly short of the threshold, no more than 500 feet, to maximize landing runway available. If circumstances dictate (IAW **paragraph 4.4.1.2**), a longer aimpoint, typically no more than 200 feet long of the threshold, may be used.

4.4.2. Transition. The transition phase is where the pilot transitions from maintaining glidepath and aimpoint to slowing the aircraft and reducing sink rate in preparation for the flare. The transition involves both a power reduction and a pitch change to shift the aimpoint long of the original point by approximately 700 feet. The goal of the transition is to arrive between the threshold and 500’ down the runway 10 knots below final approach speed and 3 to 5 feet above the ground. Gross weight, airspeed, winds, height above the runway, descent rate, and AOA affect the timing of the power reduction and the rate of pitch change. A properly trimmed aircraft will require less backstick forces on final, which will make the transition much easier.

4.4.3. Flare. The flare is where the aircraft dissipates the remaining energy to slow to touchdown speed as it maintains altitude within a couple of feet off the runway and very little sink. Ideally, the aircraft reaches touchdown speed in the landing attitude as the main gear smoothly touches the runway (fully flared). Approximate normal landing roll is computed by adding 2,500 feet to fuel remaining. For example: with 1,200 lbs, landing roll is approximately 3,700 feet. To compute total landing distance, runway before touchdown point must be added to the above figure.

4.4.4. Approach Lighting Systems. Approach lighting systems, including visual approach slope indicator (VASI) and precision approach path indicator (PAPI) systems, can help establish a safe glidepath. For normal contact approaches where the aimpoint is short of the runway, these systems are good for reference 3 to 4 miles out, but will show “low” indications inside approximately 1 mile.

4.4.4.1. Standard VASI and PAPI Systems. The standard VASI and PAPI have a 2.5 to 3-degree glide slope and a glidepath intercept point (aimpoint) approximately 750 feet beyond the runway threshold. The glidepath is normally coincidental with the ILS or precision approach radar (PAR) glide slope. When flying the standard VASI or PAPI glidepath down to the flare, expect to land up to 2,000 feet down the runway.

4.4.4.2. Nonstandard VASI System. The nonstandard VASI has a 3 to 3 1/2-degree glide slope and a glidepath intercept point approximately 450 feet short of the runway threshold. The nonstandard VASI allows you to hold an on-glidepath indication to a point just short of the runway threshold, facilitating a touchdown within the first 1,000 feet of the runway.

4.4.4.3. Other Approach Lighting Systems. Some Air Force bases use the pulsating visual approach slope indicator (PVASI); most naval air stations use the Fresnel Lens Optical Landing System (FLOLS). Refer to AFMAN 11-202, Volume 3, *Flight Operations, Aircrew Quick Reference to Aircraft Cockpit and Formation Flight Signals*; and Flight Information Publications (FLIP) for guidance on these systems.

4.5. Normal Straight-In. Normally, slow to approximately 240 KIAS on base or approximately 10 to 15 miles from touchdown on an extended straight-in. However, because local procedures or traffic deconfliction may require adjustments, avoid slowing to less than final turn airspeed for the current flap setting until established on final. Prior to intercepting the glidepath, establish the landing configuration and trim while allowing the airspeed to gradually decrease to the computed final approach airspeed (approximately 0.6 AOA). Strive to be configured at final approach speed upon intercepting the glidepath. From this point, follow procedures outlined in **paragraph 4.7**.

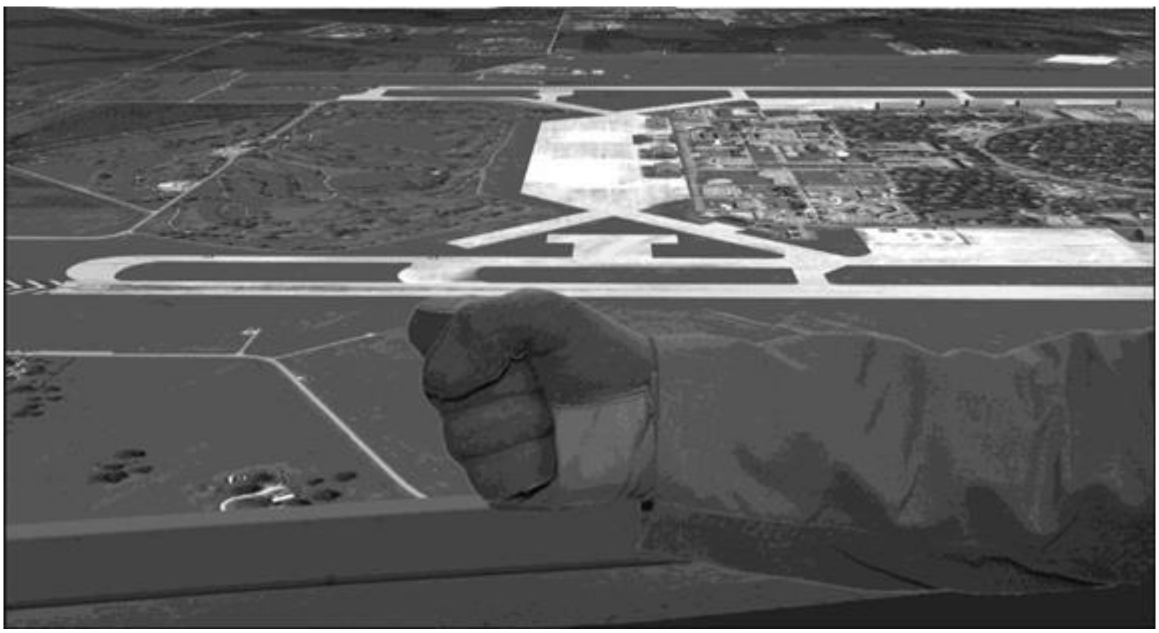
4.6. Normal Overhead (Full or 60-Percent Flaps):

4.6.1. Normal Break. The end result of the break should be a properly spaced downwind with an established drift correction while maintaining traffic pattern altitude. Unless the controller or local procedures directs otherwise, initiate the break between the approach end and 3,000 feet down the runway. Do not go into the break until you are 45 degrees off from another aircraft to ensure 3,000-foot spacing and abeam another aircraft to ensure 6,000-foot spacing. Ideally, adjust the break point for winds and vary the bank angle or back stick pressure during the break to roll out on the desired ground track. Maintain level flight during the break by pulling the pitot boom across the horizon. Slow to below 240 KIAS, but no less than final turn airspeed.

4.6.2. Normal Closed Pattern. With clearance for the closed pattern, begin the pullup with a minimum of 240 KIAS. Normally, power will be in MIL, although a closed pullup from a go-around may require less power. Execute a climbing 180-degree turn, maintaining a minimum of 200 KIAS until wings level on downwind. Consider winds (overshooting or undershooting) and establish the proper crab on rollout. Visually clear for traffic in the break and for other aircraft on downwind.

4.6.3. Normal Inside Downwind. Getting from the break or closed downwind to the perch incorporates pitch, trim, power, and configuration changes. Check runway displacement when rolling out on inside downwind and adjust spacing if needed. Normal, no-wind spacing is approximately 1 to 1.25 nm (**Figure 4.2**). As a guide, crab into wind with twice as much crab as you used on initial. Compute final turn and final approach airspeeds and strive to configure no later than abeam the touchdown point. Monitor airspeed during flap extension to prevent flap overspeed when lowering full flaps. Prior to beginning the final turn, ensure the landing gear is down and locked and the flaps have traveled a sufficient amount to ensure no asymmetry exists. As airspeed decreases to final turn airspeed, advance throttles to approximately 93% to hold final turn airspeed until reaching the perch point. Maintain a minimum of final turn airspeed. Strive to arrive at the perch at or slightly above final turn speed, on altitude, and with the proper spacing and configuration.

Figure 4.2. No-Wind Runway Displacement (1,500 feet AGL traffic pattern).



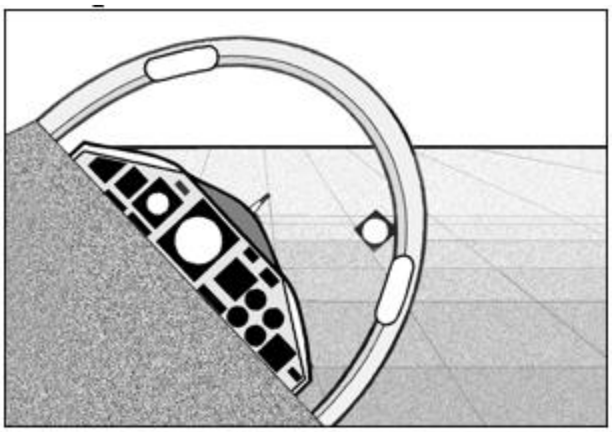
4.6.4. Final Turn. The goal of a final turn is to arrive over the desired rollout point, on the extended runway centerline, and with the appropriate heading, altitude, and airspeed. Normally, the rollout point is 300 to 375 feet AGL at 1 to 1.25 nm from the threshold. Perch abeam the no-wind rollout point, adjusted for winds. A preceding T-38 should be two-thirds of the way around the final turn to ensure 3,000 feet of landing spacing or abeam for 6,000 feet of landing spacing.

4.6.4.1. Flying the Final Turn:

4.6.4.1.1. Confirm configuration, and enter approximately a 45-degree banked turn with a shallow rate of descent, and blend in back stick pressure to establish an on-speed AOA. Then adjust power, bank, back stick pressure, and trim to hold final turn airspeed. Fly over your rollout point on altitude and crabbed into the wind, if necessary. Maintain a minimum of final turn airspeed or on-speed AOA indication (green donut), whichever is occurs first, and do not allow the airspeed to decrease below final turn airspeed until the point in the final turn where back stick pressure can be relaxed to begin final alignment with the runway.

4.6.4.1.2. A visual reference for pitch in the final turn is two-thirds ground and one-third sky in the front windscreen (**Figure 4.3**) The ADI may be used for a momentary cross-check to confirm bank angle. The VVI will eventually indicate approximately 2,000 fpm rate of descent for a 1,500-foot AGL traffic pattern. Halfway around the final turn, check the altimeter. You should lose about half the altitude between traffic pattern altitude and rollout altitude. If it becomes obvious that the final turn is nearly complete and less bank will be required to complete the turn, reduce power to begin slowing to final approach speed corresponding to the amount of bank needed to complete the turn.

Figure 4.3. Normal Final Turn.



4.6.4.2. Rolling Out on Final. When rolling out on final, crab into the wind as necessary and position the nose of the aircraft to capture the glidepath based on your desired aimpoint as you slow down. Once established on final and on airspeed, the VVI should be approximately half of what it was in the final turn (or about 800 to 900 fpm). From this point, follow procedures outlined in **paragraph 4.7**.

4.7. Normal Final Approach or Landing. On final approach, the goal is to maintain the desired glidepath, aimpoint, and final approach speed until transitioning to a flare or landing, as follows:

4.7.1. Glidepath**.** Use the runway and surrounding environment as the primary reference for establishing a 3-degree glidepath. Trim off stick pressures to aid in glidepath control. Make correction to glidepath by increasing or decreasing the current rate of descent until the desired glidepath is regained. If you need to correct for a steep glidepath, aim slightly shorter, with a commensurate power reduction to maintain final approach airspeed until reintercepting a normal 3-degree glidepath. If you need to correct for a shallow glidepath (being “drug in”), aim slightly longer and increase power slightly until reintercepting a normal 3-degree glidepath. In either case, do not allow an excessive descent or sink rate to develop or airspeed to deviate.

4.7.2. Aimpoint:

4.7.2.1. For a normal final approach (gear and full flap and on speed, no crosswind), the aimpoint will appear to be approximately in the middle of the front windscreen. This will not be a fixed point on the windscreen, but an approximation that will vary based on winds, glidepath corrections, etc.

4.7.2.2. Another way of visualizing the aimpoint is to look for relative movement of objects in the windscreen. The point on the ground that appears stationary in the windscreen is your true aimpoint. (It just grows bigger as you approach it.) This aimpoint must be maintained (assuming you are on the glidepath) until reaching the transition line. When you are on the proper glidepath, unintentionally shifting to an aimpoint beyond the desired aimpoint too soon sets up (1) a steep final and/or a long landing (proportional to the amount of shift), or (2) a situation that requires an undesirable sinking flare.

4.7.3. Airspeed. Ideally, you should fly the aircraft at the computed final approach speed and/or on-speed AOA indication (green donut), whichever is greater. With gusty winds, increase the final approach and landing speed by one-half the gust factor IAW the flight manual. Approximately 90 percent rpm will maintain onspeed indications on a normal glidepath with gear and full flaps. When making adjustments to the glidepath, a power adjustment may also be required. If there appears to be a calibration discrepancy between the airspeed and AOA indications, take all factors (such as aircraft feel) into account to determine the appropriate speed to fly. Flying a higher speed than required is far safer than attempting to fly on speed with suspect indicators.

4.7.4. Landing on Alternate Sides of the Runway. When traffic permits, land in the center of the runway. However, during a busy traffic pattern, plan the final approach and landing, using alternate sides of the runway and keeping the aircraft toward the center. Do not allow the aircraft to drift across the runway centerline. The two sides of the runway are referred to as the hot side (the side of the runway *opposite* the turnoff taxiways) and the cold side (the side of the runway *nearest to* the turnoff taxiways).

4.7.5. Transition:

4.7.5.1. As the aircraft approaches the overrun (on a normal landing), the glidepath is abandoned and the aircraft begins the transition to the flare. The sink rate is cut in half and the aircraft aim point is 200 to 300 feet beyond the landing threshold. (**Note:** The power reduction techniques stated herein assume the aircraft is on a normal glidepath and on final approach speed approaching the transition.) To cross the threshold 10 knots below final approach speed and land onspeed 500 to 1,000 feet down the runway, a few rules of thumb for power reduction can be used:

4.7.5.1.1. With a surface headwind component of 10 knots, the power should be reduced to idle approximately 1,000 to 1,500 feet short of the desired touchdown point. Several factors affect when the power reduction to idle occurs. For greater than a 10-knot headwind component, delay power reduction (as much as 500 feet per additional 10 knots) and vice versa for less than a 10-knot headwind component. Pilot technique will affect the power reduction. For a slow power reduction to idle, the power needs to start coming back slightly earlier. In all cases, back stick pressure must be applied commensurate with airspeed change to maintain the desired flightpath.

4.7.5.1.2. Most premature touchdowns are a result of insufficient back stick pressure in the transition. If the glidepath was steeper than normal and a greater pitch change will be required to arrest the sink rate, power reduction should be delayed until a normal transition line is established.

4.7.5.1.3. If you are coming in from below a normal glidepath, power should be held until a normal transition line is established (at which point the rules of thumb listed above apply). If buffet is felt during the transition, delay the power reduction or consider adding power as required to avoid stall indications.

4.7.5.2. Regardless of the power reduction, it is imperative that sufficient back stick pressure is applied to keep the aircraft on the proper transition line. A properly trimmed aircraft will require less back stick forces on final, which will make this transition much easier. If an excessive sink develops, execute a stall recovery. With a strong headwind or gusty crosswinds, use caution when reducing power to idle.

4.7.6. Flare and Landing:

4.7.6.1. A well-executed landing is a smooth, onspeed touchdown 150 to 1,000 feet down the runway. The objective is to touch down with the proper landing attitude and airspeed at a point on the runway that provides an adequate safety margin against landing short while leaving as much runway as possible for stopping—or accelerating—the aircraft.

4.7.6.2. To consistently land well, fly the aircraft down to a height just above the runway (approximately 2 feet off the ground). Then gradually increase pitch as airspeed decreases to compensate for the loss of lift and bring the main gear down to smoothly touch the runway.

4.8. Full-Stop Landing and Aerobrake:

4.8.1. Ensure the throttles are in idle. On a full-stop landing, smoothly increase back stick pressure after touchdown to attain approximately a 12-degree pitch attitude for an aerobrake. Just prior to the loss of elevator authority, lower the nosewheel to the runway. Aerobrake as appropriate for gross weight. (For example, with 1,000 pounds of fuel remaining, the maximum attitude of 12 degrees can be achieved at about 130 KIAS.) Do not aerobrake abruptly because a lightweight T-38 can leap dangerously into the air with speeds at or above the computed landing speed.

4.8.2. Smoothly fly the nose to the runway at 100 KIAS. Heavyweight aircraft stopping characteristics are different than lightweight characteristics. The nose will settle to the runway sooner following the aerobrake. Because the touchdown airspeed is higher, the stopping distance is longer and the wheel brakes will initially feel less effective. After lowering the nosewheel to the runway, keep the stick full aft to increase weight on the main gear and use cautious wheel-braking to prevent any possible skidding.

4.9. Rollout and Wheel-Braking:

4.9.1. During a landing roll, apply aileron into the wind and maintain directional control with the rudder. After lowering the nosewheel and at or below 100 knots, check for brake system pressure by gently pressing the brake pedals. To prevent possible directional control problems, make sure both pedals are applied with equal pressure in one smooth brake application. Do not pump the brakes unless a single application provides insufficient pressure.

4.9.2. Use steady braking to reduce to taxi speed. Keep the stick full aft throughout the landing roll to maximize aerodynamic deceleration. Maintain directional control with the rudder and differential braking until you reach taxi speed. Then use nosewheel steering. When routinely operating from very long runways, practice the braking technique required to stop on shorter runways.

4.9.3. When landing in the center of the runway or on the hot side, plan to cross to the cold side with speed under control and sufficient distance down the runway to prevent a conflict with other traffic. If turning off the runway prior to the end, clear for aircraft behind you on the runway before crossing to the cold side. Comply with local procedures.

4.10. Touch-and-Go Landing:

4.10.1. At touchdown, advance power to MIL (or MAX, if required) and smoothly lower the nose to the takeoff attitude or slightly below. Do not release back stick pressure abruptly. Attempt to keep the nosewheel from contacting the runway. Momentary contact is acceptable, but not desired. Check the engine instruments and accelerate to takeoff airspeed.

4.10.2. When reaching takeoff speed (approximately 10 knots below final approach speed to final approach speed), establish the takeoff attitude and allow the aircraft to fly off the runway. Then follow initial takeoff procedures. High gross weights, high temperatures, high-pressure altitudes, full flaps, etc., may adversely affect acceleration. Consider selecting afterburner under these conditions. Another technique is to retract the flaps to 60 percent until reaching 190 knots to avoid losing altitude as the flaps are retracted beyond 60 percent.

4.11. Crosswind Landing:

4.11.1. Final Approach. Counteract the drift by crabbing into the wind. Maintain the crab until touchdown. The aircraft will reduce the crab angle when both main tires are on the ground. When the crosswind component exceeds 15 knots, plan to touch down on the upwind side of the runway.

4.11.2. Full-Stop Landing:

4.11.2.1. When the crosswind component exceeds 15 knots, maintain the landing attitude and do not aerobrake. Maintaining the landing attitude requires additional back stick pressure as airspeed decreases. Increasing back stick pressure too rapidly may result in the aircraft becoming airborne or drifting across the runway.

4.11.2.2. Tire damage is highly probable if the aircraft drifts across the runway and you do not apply aileron into the wind. Maintain directional control with the rudder. Applying aileron into the wind will aid in directional control, help prevent compression of the downwind strut, and prevent the upwind wing from becoming airborne.

4.11.2.3. Just prior to the loss of elevator authority, lower the nosewheel to the runway and apply aileron into the wind. Do not lower the nose prematurely with a crosswind. Insufficient crosswind controls may result in compression of the downwind strut and poor directional control and, when combined with weathervaning, can result in damage to the downwind tire.

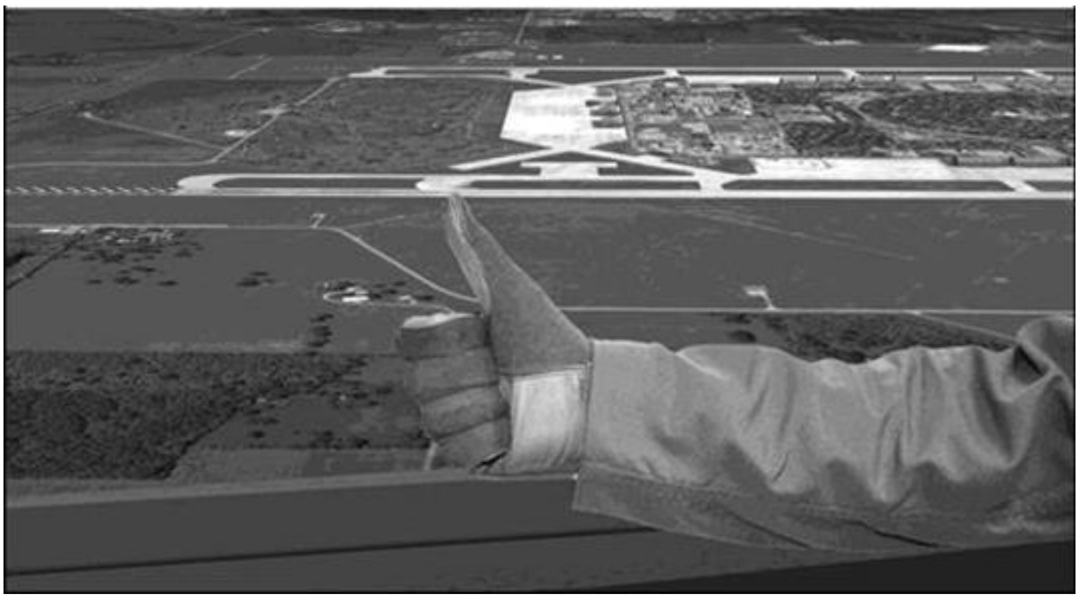
4.11.2.4. Applying these techniques during crosswind landings will increase the landing distance by approximately 50 percent. Expect to be farther down the runway when you lower the nose, with less runway remaining to stop the aircraft.

4.12. No-Flap Patterns and Landings:

4.12.1. No-Flap Straight-In. Practice a no-flap straight-in to prepare for an actual emergency that requires a no-flap landing. The basic procedures for flying the approach are the same as the normal straight-in.

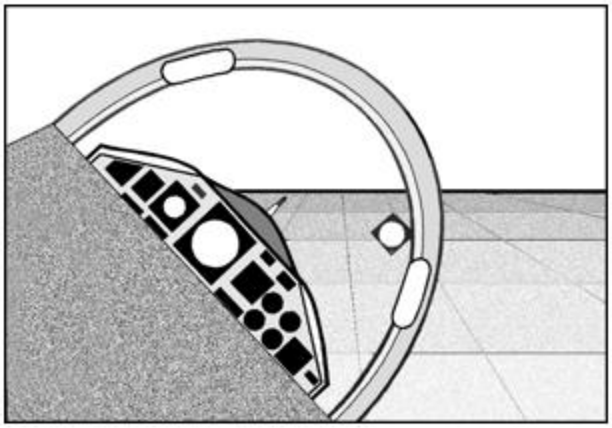
4.12.2. No-Flap Overhead. The reason we do no-flap overhead patterns is to maximize no-flap landing training. For an actual emergency requiring a no-flap landing, a straight-in approach should be flown. Due to the increased final turn airspeed and resulting increased turn radius, the no-flap pattern requires a wider downwind displacement (1.5 miles or greater, or runway a "thumbs-up" above the canopy rail. See **Figure 4.4**)

Figure 4.4. No-Flap Runway Displacement (1,500 feet AGL traffic pattern).



4.12.2.1. Flying the No-Flap Final Turn. The desired rollout point for a no-flap final turn is the same as for a normal overhead, but you are wider on a no-flap. Therefore, if you use the same visual reference (in relation to the runway) to begin the turn as on a normal pattern, you will be too long at the perch and will roll out farther from the runway at the rollout point. Confirm configuration and enter approximately a 45-degree bank turn. Let the nose of the aircraft fall very slightly and smoothly add back stick pressure to establish an onspeed AOA (green donut) or no-flap final turn airspeed, whichever is greater. The visual pitch reference for a no-flap final turn is approximately half ground and half sky and appears to be a more shallow descent (**Figure 4.5**) Trim to reduce stick pressure as pitch and airspeed change. Maintain no less than no-flap final turn airspeed or on-speed AOA (green donut) throughout the final turn and do not allow the airspeed to decrease below final turn airspeed until initiating the rollout onto final.

Figure 4.5. No-Flap Final Turn.



4.12.2.2. Rolling Out on a No-Flap Final Approach. As you roll out on final, reduce power to attain final approach airspeed as soon as practical. Because of the reduced drag with flaps up, power will need to be reduced further to slow at the same rate as an aircraft configured with full flaps. Without the flap-slab interconnect, more stick travel in pitch is required to arrest the sink rate as the glidepath is captured.

4.12.3. No-Flap Final Approach and Landing:

4.12.3.1. Select an aimpoint the same as you would for a normal final approach (**paragraph 4.7.2**) The aimpoint will appear to be about one-third of the way up from the bottom of the front windscreen. Trim off back stick pressure and monitor aim point, airspeed, and glidepath. The transition and landing phases are the same as a normal landing with the exception of pulling the power to idle. Because of the reduced drag without flaps, power reduction normally needs to begin 300 to 500 feet sooner than on an approach with full flaps. Exercise diligence to continue to fly the transition line. Without the flap-slab interconnect, the aircraft requires more stick travel in pitch to arrest the descent. One technique to ensure sufficient stick travel for the transition to landing is to smoothly pull the stick back at the same time and at the same rate that the throttles are smoothly pulled to idle.

4.12.3.2. Due to higher landing speed and less effective aerobraking on a no-flap approach and landing, expect landing distance to be approximately twice the landing distance of a normal landing at similar fuel weights. Reference the No-Flap Landing checklist in an actual emergency.

4.12.3.3. When the crosswind component exceeds 15 knots, apply the crosswind landing procedures shown in **paragraph 4.11** The no-flap crosswind landing distance will be longer than most runways.

4.13. Single-Engine Patterns and Landings:

4.13.1. Single-Engine Pattern. Fly single-engine patterns from a straight-in approach. Set the simulated failed engine not less than 60 percent rpm during a simulated, single-engine approach. Power on the good engine will be approximately 98 percent on glidepath. Use the rudder to counteract the yaw induced by asymmetrical thrust. (Step on the good engine.) Yaw will be greater during low-airspeed, maximum-thrust situations such as a single-engine go-around.

4.13.2. Single-Engine Landing. The single-engine landing is similar to the normal landing except that with 60-percent flaps selected, drag is not as great as with full flaps and power must be reduced slightly sooner than a full-flap landing under the same conditions to touch down in the same location. Ensure both throttles are checked in idle for touchdown. When performing an actual or simulated, single-engine, full-stop landing with 60 percent flaps, the landing roll will be approximately 500 feet longer. For this reason, if landing distance is critical, select full flaps when landing is assured. Consider the stopping distance critical when the computed or estimated full-flap landing distance exceeds two-thirds of the available runway.

4.13.3. Touch-and-Go From a Single-Engine Landing. Use both engines for the takeoff following a simulated single-engine touch-and-go landing.

4.13.4. Go-Around From a Single-Engine Approach. If a go-around is required for any reason other than a planned single-engine go-around practice, or an actual single-engine emergency requiring a go-around, use both engines.

4.13.5. Single-Engine Safety Considerations. Heavy fuel loads, high outside air temperatures, high-pressure altitudes, or a combination of these conditions make single-engine approaches more difficult. These conditions may also result in MIL power being insufficient to maintain level flight while configured. If these conditions exist, consider configuring the aircraft just prior to intercepting the glide slope. Use afterburner if needed to maintain final approach speed on final.

4.14. Single-Engine Go-Around:

4.14.1. The setup and planned execution should be prebriefed and may be accomplished from either a straight-in or overhead pattern. The aircraft should be stabilized on final at final approach airspeed with the simulated inoperative engine set no less than 60 percent rpm.

4.14.2. If the single-engine go-around is practiced from an overhead pattern, fly the final turn portion of the pattern with 60 percent flaps or full flaps, using both engines until rolling out on final. Once on final, simulate the engine failure, and then apply the boldface to initiate the go-around. Use coordinated rudder to offset the adverse yaw produced by one engine in afterburner. Advance the simulated inoperative engine to MIL prior to coming out of afterburner on the other engine. If an unsafe situation is developing, do not hesitate to abandon a simulated single-engine go exercise and recover the aircraft using both engines.

4.15. Low-Closed Traffic Pattern. Use this traffic pattern to practice circling approach procedures. Prerequisites for requesting a low-closed traffic pattern are the same as for the closed traffic pattern. Adjust the pullup to attain the published low-closed altitude and proper downwind displacement. Be aware of the reduced power and pitch requirements because the downwind altitude is lower. From the downwind position, fly the practice circling approach as described in paragraphs **6.17 and 7.15**.

4.16. Traffic Pattern Irregularities:

4.16.1. Excessive Sink Rates:

4.16.1.1. Excessive sink rates can develop at any time in the traffic pattern. If sink rates are allowed to continue, recovery may not be possible due to slow engine response time, lack of excess thrust, and/or insufficient altitude.

4.16.1.2. Excessive sink rates are generally not accompanied by approach-to-stall indications. Vertical velocity is the primary indication of excessive sink rate. However, the VVI is a lag instrument, so pilots must also monitor descent rates using visual glidepath references.

4.16.1.3. In the final turn from a standard 1,500-foot overhead pattern, a VVI in excess of 4,000 fpm is an indication of an excessive sink rate condition. Excessive VVI is accompanied by ground rush at approximately 10 percent of the VVI. On short final approach, a VVI of 2,000 fpm is usually too much. In most mishaps, the sink rates developed first, followed by a stall during the recovery. NOTE: Any time you encounter an excessive sink rate in the traffic pattern, immediately execute a stall recovery. Proper stall or sink rate recovery procedures take priority over maintaining the published ground track.

4.16.2. Stall Indications in the Traffic Pattern:

4.16.2.1. In the traffic pattern, execute the stall recovery any time you encounter stall indications. Approach to stall indications can include a heavy, low-frequency buffet and, in most cases, moderate wing rock. The actual stall is indicated by a combination of a very high sink rate, heavy buffet, and high AOA (above 1.0). Because the actual stall is difficult to recognize, training and recovery techniques must concentrate on approach-to-stall characteristics and stall prevention.

4.16.2.2. The definite increase in buffet intensity will normally occur close to 0.8 AOA, indicating the approach to stall. Individual aircraft performance may differ. Approach-to-stall characteristics include:

4.16.2.2.1. Gradual buffet progression.

4.16.2.2.2. Normal gear and flap vibration.

4.16.2.2.3. Definite increase in buffet intensity.

4.16.2.2.4. At 0.8 AOA.

4.16.2.2.5. Low-frequency, high-intensity airframe buffet.

4.16.2.2.6. Glare shield shaking, erratic buffet (no set frequency).

4.16.2.2.7. Wingtips stall first and may cause a wing to drop.

4.16.2.2.8. Light wing rock due to alternately stalling wingtips.

4.16.3. Recovery Procedures for Stall, Approach-to-Stall, or Excessive Sink Rate:

4.16.3.1. Simultaneously advance both throttles to MAX, relax back stick pressure, and roll the wings level. The rudder can be an effective way to initiate the roll to wings level, but use caution to avoid overcontrolling. After the wings are level, maintain moderate buffet with positive nose track until establishing a climb.

4.16.3.2. Once a safe climb has been established and obstacle clearance is assured, relax back stick pressure to allow the aircraft to accelerate. Avoid a heavy buffet or secondary stall during the recovery. Because decreasing bank significantly reduces the stall speed, there should be very little delay in starting the nose up after the wings are level from a final turn (accelerated) stall. Airspeed can also be used as an indication of maximizing performance. In general, airspeed should remain constant or increase slightly during the recovery.

4.16.4. Avoiding Stall or Sink Rate Situations. Avoiding a situation that can lead to a stall or sink rate is the best way to prevent such a situation. Four pilot-controlled variables determine controlled patterns—attitude, airspeed, configuration, and power. When one or more of these variables is flown incorrectly, pilots tend to allow a sink rate to develop in order to hold the other variables in the optimum range. For example, a pattern can appear normal in every respect as long as the pilot allows a sink rate to compensate for an improperly set bug speed. Any combination of situations can rapidly deteriorate into a stalled or sink rate condition without exaggerating any single condition. Some of these situations include the following:

4.16.4.1. Beginning the final turn with an improper configuration, less than the computed final turn airspeed, inadequate downwind displacement, or an excessively nose-low attitude.

4.16.4.2. Flying a stabilized final turn with more than 0.6 AOA, steady red chevron, or 45 degrees of bank.

4.16.4.3. Using very low power settings.

4.16.4.4. Making abrupt control movements.

4.16.4.5. Overbanking to correct an overshooting final turn.

4.16.5. Rudder Overcontrol**.** When configured, the T-38's 30 degrees of available rudder is highly effective in rolling the aircraft. Although the rudder is not needed to coordinate flight, you may use it during turns. To prevent overcontrolling, use only small rudder inputs. When using the rudder for turns, neutralize it quickly to prevent an overcontrol situation. Do not attempt to correct drift by simply yawing the aircraft. Instead, bank the aircraft and turn to a new heading. If a large heading change is needed to correct drift or centerline displacement in the flare, execute a go-around. In all cases, exercise caution to avoid overcontrolling with the rudder.

4.16.6. Balloons, Bounces, and High Flares:

4.16.6.1. Balloons, bounces, and high flares are the result of abrupt control inputs in the transition and flare or a misjudgment of the height above runway. They can all result in the same dangerous situation—an aircraft above the runway with insufficient airspeed for a controlled descent.

4.16.6.2. In mild cases, they may only result in a firm landing. In extreme cases, they can result in a wing rock, wingtip contact with the runway, or departure from the prepared surface.

4.16.6.3. For minor deviations, reestablish the landing attitude and continue with a flare and touchdown. For larger or more pronounced deviations, immediately perform a go-around. Simultaneously select MIL or MAX power and establish a safe pitch attitude. You may need to fly the aircraft back to the runway or accept a hard landing and/or bounce while waiting for acceleration. In all cases, use extreme caution to avoid approach-to-stall indications or wing rock. Recovery should appear much like a landing attitude stall recovery with most of your concentration focused on keeping the wings level and flightpath down the runway.

4.16.7. Porpoise. A porpoise is a series of bounces between the main gear and nose gear, which is the result of improper control inputs during the touchdown. If a porpoise action begins, do not attempt to counter it with fore and aft stick movements. Due to the aerodynamic forces acting on the aircraft and a possible delay in stick movements caused by reaction time, your inputs may aggravate the problem. The best remedy for a porpoise is to freeze the control stick slightly aft of neutral and execute a go-around with MAX power.

4.16.8. Overrotation. An abrupt or excessive application of back stick pressure during a takeoff usually causes overrotation. However, during a touch-and-go landing, maintaining the landing attitude while increasing the power may also cause overrotation. Overrotation can lead to a premature liftoff at a potentially dangerous airspeed. To correct this situation, establish the normal takeoff attitude, select MAX if necessary, and allow the aircraft to accelerate.

4.17. Go-Around:

4.17.1. Go-Around From the Final or Landing Phase. Advance power to MIL (MAX, if required), accelerate to a minimum of final approach airspeed, and retract the landing gear only after ensuring touchdown will not occur. Ensure sufficient airspeed exists before retracting the flaps. Climb, following local procedures for ground track and altitudes. Use caution to not overspeed the gear, gear doors, or flaps. If the runway is clear, you do not have to offset to the side of the runway.

4.17.2. Go-Around From the Final Turn:

4.17.2.1. On a go-around from the final turn, the potential for overspeed is high. Therefore, cross-check your flight parameters during the go-around. MIL is not always required in these situations. To execute a go-around from the final turn, maintain a minimum of final turn airspeed, climb or descend as required, and retract the gear and flaps only after attaining a safe flying airspeed. If the runway is clear, you do not have to offset to the side of the runway. Maintain 240 to 300 KIAS on the go-around.

4.17.2.2. With the aircraft under control and if time permits, notify the runway supervisory unit (RSU) or tower when initiating a go-around. Never break out from the final turn; execute a go-around instead. Consider lowering flaps when going around from an overshooting, no-flap final turn. (Watch for flap overspeeds as well.) If a dangerous situation develops, do not attempt to conform to the prescribed traffic pattern ground track. Your first priority is to maintain aircraft control.

4.17.3. Touching Down During a Go-Around. If an airborne go-around is impossible, continue to fly the aircraft to touchdown. Do not attempt to hold the aircraft off the runway in a nose-high attitude. Instead, maintain the landing attitude and accept a touchdown. Then perform a takeoff in the same manner as the takeoff phase of a touch-and-go landing, using MAX power if necessary.

4.18. Alternate Gear Extension. Allow extra time for the gear extension when using the alternate system. After practicing an alternate gear extension, ensure the alternate release handle is fully stowed. Then reset the landing gear system. Accomplish this by moving the landing gear handle down, then up, and then back to the down position. When accomplishing an alternate extension, lower the flaps, as required, before lowering the gear IAW the flight manual.

4.19. Abnormal Procedures:

4.19.1. Alternate Gear Extension. Under conditions requiring alternate gear extension, the front cockpit pilot must be prepared to lower the landing gear with the alternate gear release handle. Without intercom, the rear seat occupant may signal the need to use the alternate gear release system by lowering the landing gear handle.

4.19.2. Hypoxia and Hyperventilation:

4.19.2.1. A conscientious preflight of oxygen equipment—both personal and aircraft—and thorough in-flight oxygen checks are the best safeguards against hypoxia.

4.19.2.2. If you are dual and experiencing symptoms of hypoxia or hyperventilation, gang-load the regulator and inform the other crewmember.

4.19.2.3. When you land, a flight surgeon and qualified maintenance personnel should meet you at the aircraft. Maintenance personnel will inspect the aircraft oxygen system and your personal equipment. Unless you know or suspect the oxygen system is contaminated, remain connected to it until cleared to disconnect by the flight surgeon.

4.19.3. HSI Failure. In the T-38, using a magnetic compass as the sole heading reference is an emergency procedure. If the HSI heading is unreliable, attempt to use the magnetic compass for timed turns to headings. If only the slaving function of the HSI is inoperative, try to use the direct gyro position. In this situation, determine headings with the magnetic compass when straight and level and use the HSI to turn the desired number of degrees.

4.19.4. Airspeed Indicator Malfunction. With a known or suspected airspeed indicator malfunction, ensure the pitot heat is on and establish a known power setting and/or fuel flow for the desired cruise airspeed. If possible, use a chase aircraft for recovery. If one is not available, use known power settings and/or fuel flows in combination with the AOA system to approximate desired airspeeds. (0.3 AOA equals 230 + gas; a 0.5 AOA usually indicates a safe gear-lowering speed.) You can use the AOA system to safely recover the aircraft because it is independent of the pitot static system.

4.19.5. Bird Strike. A bird strike poses a hazard to low-altitude operations, particularly in the traffic pattern and on low-level navigation routes. The two most serious forms of damage from bird strikes are engine failure and cockpit penetration. Due to the critical nature of cockpit penetration, thoroughly brief procedures for transfer of aircraft control and reestablishment of intercockpit communications.

4.19.6. Go/No-Go Decisions From a Touch-and-Go Landing. Although TOLD for touch-and-go landings is impractical, the following rules of thumb are useful:

4.19.6.1. Normally, at or near the point of touchdown, both an abort and a takeoff are safe options, even with a single-engine failure.

4.19.6.2. The abort is possible because the aircraft is lighter than on initial takeoff. Barring a catastrophic, compound problem, the takeoff is equally safe. At touchdown, the aircraft is no more than 25 knots below final approach speed with most of the runway remaining. In most cases, either option will work, provided you stick to your original decision and correctly apply the procedures.

4.19.6.3. The go/no-go decision is largely a matter of pilot preference, but one common technique is to consider the throttle position. That is, if the throttles are in idle when the problem occurs, leave them there because you are psychologically prepared to land. However, if you have advanced the throttles and/or they have stabilized in MIL power, consider continuing the takeoff. Another technique you can use when a BAK-15 barrier is available is to use the takeoff speed (main gear liftoff) for a go/no-go speed. In either case, apply the appropriate boldface for the selected decision.

4.19.6.4. As with other emergency situations, you should weigh all factors, including the runway remaining, runway condition, configuration, aircraft weight, weather, barrier type, and obstacles on departure. In any case, two fundamental questions will serve you well—Is a safe abort possible? and Is a safe takeoff possible? Take the time to answer these questions on the ground—before you fly. This discussion highlights why we emphasize landing on speed in the desired landing zone—to provide maximum runway remaining to stop (or go) during an emergency.

4.19.7. After-Landing Procedures With an Emergency. If you need assistance from fire department or maintenance personnel following an emergency landing, hold the brakes and raise both hands. This signals to the ground crew that they are clear to inspect the aircraft. Do not actuate switches without visual coordination with the ground crew.

Chapter 5

CONTACT

Section 5A—General Methods and Procedures

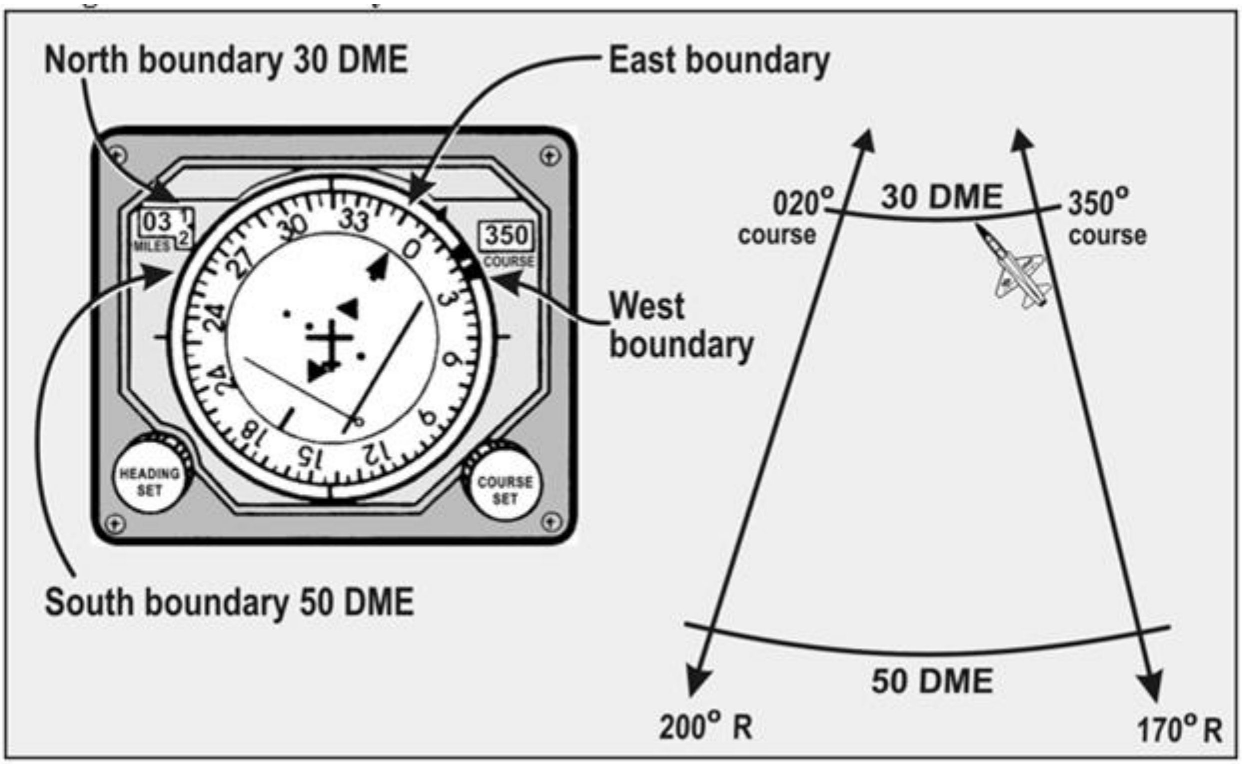
5.1. Introduction. The basic objective of contact flying in the T-38 is to build a solid feel for the aircraft's performance capabilities through a large portion of its flight envelope, including stalls, aerobatics, advanced handling characteristics, and normal and emergency traffic patterns.

5.2. Area Orientation. Maintain area orientation using all available means (ground references and navigational aids [NAVAID]). Ground references should be the primary reference, when available. There are two methods of using the TACAN—center radial and pie-in-the-sky, as follows:

5.2.1. Center Radial Method. This technique is best used in narrow areas (20 radials wide or less). Dial the center radial into the CSW. The center of the area is always toward the CDI.

5.2.2. Pie-in-the-Sky Method. This technique is best used in wide areas (20 radials wide or more). Set one course boundary in the CSW and mark the other course boundary with the heading marker. Keep the head of the bearing pointer—which always falls—between the head of the course arrow and the heading marker. **Figure 5.1** illustrates an aircraft's position in the area and the corresponding HSI depiction. In this example, if heading remains constant, the aircraft will exit the area due to the distance measuring equipment (DME) range. A left turn to approximately 190 degrees will make the bearing pointer fall toward the 020-degree course and make the DME increase.

Figure 5.1. Pie-in-the-Sky Method.



5.3. Energy Management:

5.3.1. General. Energy management requires maintaining effective combinations of altitude, airspeed, power settings, and AOA or G-loading. Airspeed provides the kinetic energy required to maneuver the aircraft. Altitude provides potential energy that may be exchanged for airspeed. Power settings, AOA or G-loading, and plane of motion (POM) control can be used to gain or lose energy.

5.3.2. Exchanging Altitude and Airspeed. Altitude and airspeed can be traded at a given rate. The most common rule of thumb is 1,000 feet of altitude is worth about 50 knots of airspeed. You can exchange altitude and airspeed in these proportions by using MIL power with the canopy bow on the horizon or 80 to 85 percent rpm at 20 degrees nose-high.

5.3.3. Optimum Energy Level. To do aerobatic maneuvering in a standard working airspace, the optimum energy level allowing you to do nearly all maneuvers is 300 KIAS at an altitude midway between the top and the bottom of the working airspace. Minimum and equivalent energy levels (the altitude-airspeed relationship) may be calculated, using the 50 knots at 1,000 feet exchange rate rule shown earlier in this paragraph. For example, 16,000 feet MSL at 300 KIAS is approximately the same energy level as 14,000 feet MSL at 400 KIAS.

5.3.4. Losing Energy. Losing energy is easy through the use of low power settings, increased drag due to configuration or speed brakes, and/or increased AOA/G-loading. A simple way to lose energy is to perform a constant speed descent until the desired energy level is reached.

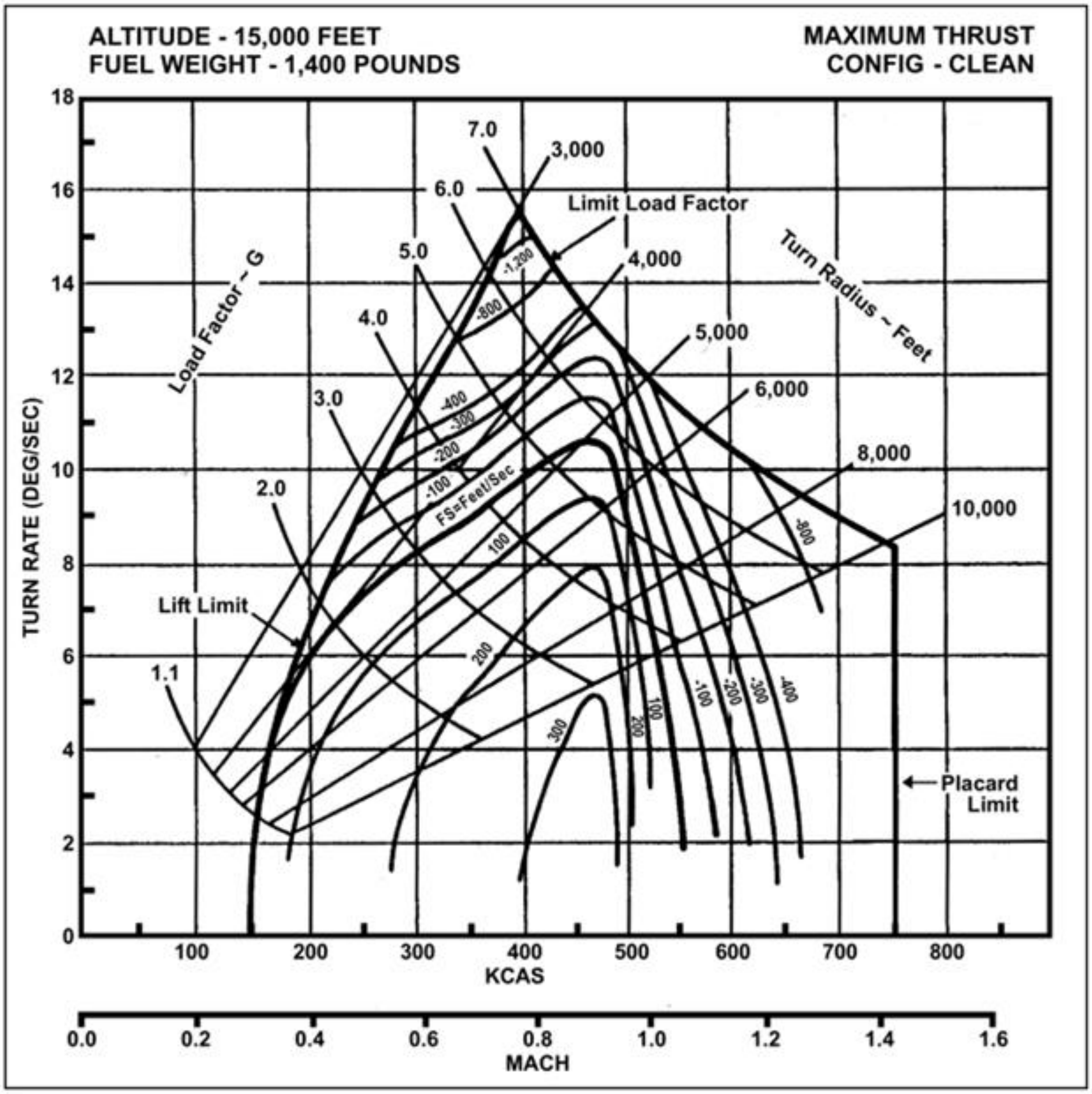
5.3.5. Gaining Energy. Gaining energy is enhanced with light AOA or G-loading and maximization of excess thrust with the aircraft lift vector pointed vertically. MAX power could be used (within engine envelope restrictions), but is rarely the most fuel-efficient way to gain energy. Many pilots will use MIL power for most energy gaining maneuvers. Do not hesitate to use MAX power for small, quick changes in airspeed or when the aircraft is already at a high indicated airspeed (IAS).

5.3.6. Maneuverability Diagrams:

5.3.6.1. An energy maneuverability diagram (**Figure 5.2**) plots airspeed or Mach against turn rate with lines of constant G-load, turn radius, and specific excess power (PS or “P-sub-S”). PS contours represent the performance capabilities of an aircraft for a given set of flight conditions, including altitude, configuration, weight, and power setting.

5.3.6.2. The lines on the diagram represent the aircraft's ability to change altitude, airspeed, and direction of flight by considering lift, aerodynamic drag, structural limits, thrust, weight, and velocity.

Figure 5.2. Energy Maneuverability Diagram.



5.4. Flight Control Characteristics:

5.4.1. Rudder. Effective use of the rudder is important throughout the flight regime of the T-38 and should not be ignored. Generally, the rudder is more effective at high AOA and less effective at low AOA.

5.4.2. Ailerons. Ailerons are most effective at low AOA and become less effective as AOA increases. Be cautious of aileron sensitivity and rapid aircraft roll rates, especially at low AOA. At high speeds and low AOA, large stick deflections may exceed aircraft limits.

5.4.3. Speed Brake. The speed brake has minimal effect below 250 KIAS. Little or no pitch change occurs when activating the speed brake below 250 KIAS. At airspeeds above 250

KIAS, speed brake extension causes a slight pitch up where retraction causes a slight pitch down. Pitch changes are not abrupt; you can easily overcome them with smooth control inputs.

5.4.4. Trim Techniques. Proper trim technique is essential for smooth and precise aircraft control during all phases of flight. The basic rule for proper trim is simple—establish and hold a desired attitude by applying control stick pressure and then trim to relieve the pressure. Normally, large trim changes are not necessary. Use “clicks” of trim when trimming the aircraft to aid in precise trim control.

5.5. Pilot-Induced Oscillation (PIO). Overcontrolling pitch corrections can result in PIOs, especially at high airspeeds. During PIOs, your control inputs lag behind the aerodynamic forces acting on the aircraft, and flight deviations will actually increase as you try to correct them. To avoid this potentially dangerous situation, make smooth control inputs. If you encounter PIOs, freeze the stick slightly aft of neutral until oscillations stop.

5.6. G-Awareness Exercise. Perform the G-awareness exercise to warm up or assess your personal G-tolerance and practice the timing and execution of your anti-G straining maneuver. Also check your G-suit and the aircraft’s system for proper operation. Use MIL power and 420 to 450 KIAS to provide adequate airspeed to sustain the appropriate Gs without losing excessive altitude. At a minimum, accomplish a 90-degree turn at 4 Gs and a 180-degree turn at 5 Gs. Attempt to keep the altitude loss to a minimum during the turns. Perform a G-awareness exercise any time more than 4 Gs are planned during the profile. Note: See AFPAM 11-419, *G Awareness for Aircrew* for more information on G awareness.

Section 5B—Aircraft Handling Maneuvers

5.7. General. The exercises in this section display the handling characteristics and qualities of high-performance, swept-wing aircraft. They are exercises, not precise maneuvers. It is more important to develop a feel for handling characteristics than to achieve specific parameters. When observing or flying these exercises, note when the flight control surfaces are most effective and how airspeed and AOA changes affect the aircraft’s handling characteristics.

5.8. Full Aft-Stick Stall:

5.8.1. This stall demonstrates aircraft characteristics throughout the stall regime and shows the importance and effectiveness of relaxing back stick pressure during a stall recovery. In this stall, the stall progresses far beyond the situation encountered in normal flight or approach-to-stall training.

5.8.2. This exercise demonstrates the aircraft’s stability in a stall, the ability to recover from any stall simply by relaxing back stick pressure, and the excessive altitude lost when recovering from a stall without using increased power. Always consider increasing power to minimize altitude loss in an inadvertent stall recovery.

5.8.3. Begin in level flight below FL 200 with power set at 80 percent rpm minimum.

5.8.4. As airspeed decreases, hold the pitch constant by smoothly and steadily pulling the stick straight back to the stop with no aileron inputs. Mild wing rock is normal as AOA increases.

5.8.5. As you approach full aft stick, wing rock will occur and a high sink rate will develop. Keep the ailerons neutral and the stick full aft against the stop. Note the buffet and AOA progression—especially the increased buffet around 0.8 AOA, full stall around 1.0 AOA, and fully developed stall at 1.1 AOA. In the fully developed stall, pitch stabilizes slightly nose-low, airspeed settles around 140 KIAS, AOA reaches the stop at 1.1, and VVI increases to a 6,000 fpm descent.

5.8.6. After the stall is fully developed, recover by leaving the power alone and relaxing back stick pressure. As the airspeed increases, reapply back stick pressure and add power as required. Recover to a level-flight attitude. Use caution not to overspeed the gear and/or flaps during the recovery.

5.8.7. Slight variations in aircraft rigging, coupled with flight control inputs, may cause severe wing rock. If bank exceeds 90 degrees or stabilizes over 60 degrees, discontinue the exercise and recover the aircraft from the stall. Watch for potential gear or flap overspeed if configured. Write the aircraft up; the mission may be continued.

5.9. Simulated Trim Failure:

5.9.1. Simulated inoperative trim will familiarize you with the stick pressures required when the elevator trim fails. If you release pressure on the control stick after the elevator trim has failed, the stick will move to the trimmed position and the aircraft will aerodynamically search for the trimmed airspeed.

5.9.2. Perform this exercise below FL 200. Begin with airspeed above 300 KIAS and trim the aircraft for level flight. Without retrimming, slow the aircraft to normal final approach airspeed. As the airspeed decreases below 240 KIAS, configure the aircraft with gear and full flaps. Note the increase in stick forces as the airspeed decreases and the configuration changes.

5.9.3. After experiencing the pressures at final approach airspeed, retrim the aircraft to relieve the stick pressures. Without trimming the aircraft, execute a simulated go-around, retracting the gear and flaps and accelerate to an airspeed above 300 KIAS. Note the increasing stick pressures associated with the configuration and airspeed changes. Turn the aircraft and note how increased bank helps maintain altitude and provide relief from the constant forward stick pressures.

5.9.4. After completing the exercise and before any other maneuvering, retrim the aircraft. If you encounter approach-to-stall indications at any time, simultaneously execute stall recovery procedures and retrim the aircraft to eliminate unwanted stick pressures.

5.10. Rudder Effectiveness Exercise (Clean):

5.10.1. This exercise demonstrates the increased effectiveness of the rudder at increased G-loads and AOA and its decreased effectiveness at decreased G-loads and AOA.

5.10.2. With the power set between 85 percent rpm and MIL, roll the aircraft at various G-loads and AOA, using only rudder inputs. Establish a 20-degree, nose-high pitch attitude with 300 KIAS. Set the power at approximately 90 percent rpm and increase back stick pressure to attain a light buffet.

5.10.3. Next, while maintaining the ailerons in a neutral position, smoothly apply full rudder to roll the aircraft. Notice that the rudder is effective at rolling the aircraft.

5.10.4. Using the same power setting and airspeed, smoothly unload the aircraft to approximately ½ G. Maintain the ailerons in a neutral position and apply full rudder. Notice that little roll results. Without changing the rudder input, gradually increase back stick pressure to attain a light buffet. Notice how the aircraft rolls in the direction of the applied rudder and how the roll rate increases with the increasing AOA.

5.10.5. Avoid entering a fully stalled condition (AOA approaching 1.0 or higher) during any part of the exercise. At a constant AOA, as you increase airspeed, roll rate increases with the same rudder deflection. At zero AOA, the aircraft will yaw, but not roll very much with rudder applications. Remember, you have 6 degrees of rudder travel with the gear up versus 30 degrees of rudder travel with the gear down.

5.11. Rudder Effectiveness Exercise (Configured):

5.11.1. This exercise demonstrates flight characteristics during the landing phase and the measurable delay between the time a rudder input is applied and the time it takes effect on the aircraft. With the aircraft configured with gear down and flaps at any setting (for example, full, 60 percent, or no-flap), apply varied amounts of rudder inputs for varying lengths of time and examine the roll characteristics.

5.11.2. First, configure the aircraft and achieve a level attitude with approach-to-stall parameters (approximately 0.8 to 0.85 AOA).

5.11.3. Then, as quickly as possible, apply full rudder deflection and return the rudders to neutral. Keep the control stick in approximately the same position throughout the maneuver to maintain AOA. Maintain neutral aileron inputs to isolate rudder characteristics.

5.11.4. After a delay of 1 to 2 seconds, the aircraft will roll into approximately 90 degrees of bank. NOTE: When applying near-full rudder deflection, it is important to return the rudder to neutral quickly to avoid excessive bank.

5.11.5. Recover the aircraft, using controlled rudder to return to level flight.

5.12. Aileron Effectiveness Exercise:

5.12.1. This exercise demonstrates the increased effectiveness of the ailerons at low G-loads and AOA. With the power set between 85 percent rpm and MIL power, roll the aircraft at various G-loads and AOA, using only the ailerons. One technique is to establish a 20-degree, nose-high pitch attitude, set the power at approximately 90 percent rpm, and allow the airspeed to decrease to 150 KIAS.

5.12.2. At 150 KIAS, increase back stick pressure to attain a moderate buffet. Maintain this buffet and roll the aircraft, using the ailerons. Note the roll rate.

5.12.3. Then, while maintaining a moderate buffet and the same aileron deflection, smoothly unload the aircraft to approximately 1/2 G. Note how the roll rate increases.

5.12.4. Ailerons become more effective as the AOA decreases, regardless of airspeed. Relaxing back stick pressure will reduce the AOA and increase aileron effectiveness.

5.13. Acceleration Exercise:

5.13.1. This exercise demonstrates the effect of induced drag on aircraft acceleration. Initially, enter the exercise from a 1 G straight-and-level flight with 250 KIAS. While maintaining 1 G, advance the throttles to MIL or MAX and note the time required to accelerate to 350 KIAS. Reestablish 250 KIAS in a wings-level attitude and accelerate to 350 KIAS at approximately zero G with MIL or MAX power. Again, note the time required to accelerate.

5.13.2. For a more dramatic demonstration, enter the exercise at 300 KIAS in a 2 to 3 G turn. While maintaining the 2 to 3 G turn, attempt to accelerate to 400 KIAS with MIL or MAX power. Note how slowly the aircraft accelerates. Next, reestablish 300 KIAS in a 2 to 3 G turn. Maintain the bank, but unload the aircraft to approximately zero G and accelerate to 400 KIAS with MIL or MAX power. Again, note how much more quickly the aircraft accelerates.

5.13.3. After the initial demonstration, accomplish this exercise at any airspeed and with any bank angle by unloading to approximately zero G and accelerating with a minimum of MIL power. Use this zero G acceleration whenever you need an increase in airspeed or energy, not just when you are demonstrating aircraft acceleration capabilities.

5.14. Accelerated Stall:

5.14.1. This stall demonstrates the effect that increasing AOA has on turning performance and airspeed loss. For this exercise, use approximately 300 KIAS to decrease the necessary G-loading and reduce the time required to reach the increased buffet or mild wing rock.

5.14.2. Begin by entering a 2 to 3 G turn with MIL power and approximately 300 KIAS. Increase the bank and back stick pressure as required to achieve the light buffet in a level turn. Note the turn rate. This is optimum turn performance for the T-38.

5.14.3. Then rapidly increase the bank and back stick pressure to achieve either increased buffet or mild wing rock. Note that the turn rate will increase initially; but, as the AOA continues to increase, the turn rate will decrease and the airspeed loss will increase.

5.14.4. Without reference to any cockpit indications, you should be able to note when the AOA has increased beyond a useful point. Next, relax the back stick pressure to decrease the AOA and continue the turn with a light buffet.

5.15. Turn Reversals:

5.15.1. This exercise demonstrates the differences between rolling the aircraft with ailerons alone under a low AOA condition and rolling the aircraft with the rudder alone under higher AOA conditions. The order in which you accomplish the turns is not important, but both turns should be accomplished between 350 to 400 KIAS with a minimum of MIL power.

5.15.2. For both turns, roll the aircraft into approximately 90 degrees of bank and increase the back stick pressure to achieve approximately 4 Gs. Be careful not to exceed the asymmetrical G limits of the aircraft during this exercise.

5.15.3. After establishing 4 Gs, accomplish one reversal by unloading the aircraft and using only the ailerons. Then reestablish a 4 G turn in the opposite direction. Note how quickly you accomplish the roll and how little airspeed you lose during the reversal.

5.15.4. After establishing 4 Gs again, accomplish one reversal by using only the rudder. Altitude and energy will determine whether you use the top or bottom rudder. If you use the top rudder, note the airspeed bleed off during the reversal. If you use the bottom rudder, note the altitude loss. In both cases, the reversal will be slower than the one accomplished with ailerons and a low AOA.

5.16. Pitchback:

5.16.1. Pilots use a pitchback to reverse the direction of flight in minimum time while losing excess energy to attain and maintain corner velocity. A pitchback is similar to an Immelmann except it begins with a bank angle greater than 0 degrees (but less than 90 degrees) and uses less altitude. The objective is to minimize turn time while maneuvering, using visual references. Concentrate on the simple mechanics of flying a pitchback without regard to energy level or corner velocity.

5.16.2. Enter the pitchback from level flight with 450 to 500 KIAS. With the power stabilized between 550 degrees EGT and MIL, roll to the desired bank angle, neutralize the ailerons, and apply back stick pressure to attain 4 to 5 Gs. Maintain 4 to 5 Gs or a light buffet as airspeed decreases and a straight nose track through approximately 180 degrees of turn.

5.17. Sliceback. A sliceback is similar to a split-S except it begins with a bank angle greater than 90 degrees, but less than 180 degrees, and uses less altitude. The objective is to reverse the direction of travel, using potential energy (altitude) to maintain airspeed. Enter the sliceback with 200 to 300 KIAS. With the power stabilized between 90 percent rpm and MIL, roll to the desired bank angle, neutralize the ailerons, and apply back stick pressure to attain a light buffet. Maintain the light buffet and a straight nose track through approximately 180 degrees of turn. The higher the entry airspeed, the more you need to watch the Gs at the bottom and use caution for rolling inputs, which could cause an asymmetrical over-G.

5.18. Low-Speed Stability Exercise:

5.18.1. Commonly referred to as the “stab ex,” or “stab demo,” this exercise demonstrates the stability potential of high performance aircraft at extremely low airspeeds. Establish a 60-degree, nose-high pitch attitude and set power at a minimum of 85 percent rpm. Use the power setting to control the airspeed bleed off and altitude gain.

5.18.2. As the airspeed decreases through 170 KIAS, unload the aircraft and maintain approximately 1/2 G. With the aircraft unloaded, note how far the airspeed decreases without stall indications or loss of control. As the aircraft passes level-flight attitude, apply back stick pressure and attempt to maintain level flight. Note the immediate onset of stall indications.

5.18.3. Once again, unload the aircraft and note how stall indications cease. Maintain 1/2 G until reaching an airspeed between 175 and 200 KIAS; then recover the aircraft to level flight. Maintain at least 1/2 G throughout this maneuver to ensure proper oil system operation. If the airspeed decreases below elevator effectiveness, the aircraft will immediately stall and may enter post-stall gyrations.

5.18.4. Because the coefficient of lift for a symmetrical airfoil is always zero at zero G, the wing cannot exceed the critical AOA. Therefore, when faced with a nose-high, low-airspeed, unusual attitude, unloading the aircraft will ensure aircraft control as long as possible.

5.19. Supersonic Flight. This exercise explores the supersonic flight regime and supersonic handling characteristics of high performance aircraft.

5.19.1. Planning. Due to its unique nature, this type of flight requires additional planning considerations. Prior to the preflight briefing, check the forecast temperature at the supersonic run altitude and review engine operating limitations, associated emergency procedures, the afterburner climb schedule, and any local coordination requirements and restrictions.

5.19.2. Exercise:

5.19.2.1. Unless locally directed otherwise, use an altitude below FL 400 for acceleration into the supersonic regime. Although this altitude may place the aircraft in the shaded area of the Engine Compressor Stall/Flameout Susceptibility chart in the flight manual, it provides an adequate buffer for maneuvering above FL 300.

5.19.2.2. With a slight descent to sustain supersonic flight, establish a turn with increasing bank and back stick pressure. Note the maximum turn rate and G-loading available with the decreased elevator performance. Due to the possibility of an over-G, do not allow the aircraft to transition from supersonic to subsonic flight while maneuvering under G.

5.19.2.3. The single significant consequence of going supersonic is wave drag. This increase in total drag starts slightly above critical Mach (noticeable by .95 Mach). The transition from subsonic to supersonic flight occurs with little apparent aircraft reaction. At Mach 1, a detached shock wave forms in front of the pitot tube, causing the altimeter and VVI indications to jump. Because the engines are operating in an area of increased stall susceptibility, use caution when terminating the supersonic run. Smoothly retard one throttle out of afterburner, and ensure proper engine operation before retarding the second throttle out of afterburner. Also, do not allow the airspeed to decrease below the IMN recommended in the flight manual. Finally, use caution to prevent exceeding Mach 1 during the descent below FL 300.

5.20. Slow Flight. This type of flight demonstrates the low-speed handling characteristics of the T-38 and emphasizes the importance of smooth control inputs during this flight condition. After configuring, slow to an airspeed 10 knots below computed final approach airspeed. Normally, slow flight should be accomplished in level flight, but a slight descent may be required. The AOA indexer lights will show a slow indication (red chevron or red chevron with green donut, approximately 0.7 AOA). Perform coordinated turns, using various angles of bank. Note how the AOA changes with fore and aft stick movements, throttle movements, and changes in bank.

5.21. Slow Flight Recovery Demonstration:

5.21.1. This demonstration shows the effects of various flap settings on aircraft acceleration at low airspeeds. It is particularly applicable to aircraft handling during the flare and/or go-around.

5.21.2. In level flight with gear down, full flaps, slow flight airspeed, and a constant power setting, retract the flaps to 60 percent. Note how the aircraft accelerates and the AOA decreases. Reestablish full flaps and slow flight airspeed. When stabilized in level flight and while maintaining a constant power setting, fully retract the flaps. Note that, as the flaps pass through 60 percent, the aircraft starts to accelerate and the AOA decreases. As the flaps continue toward the full-up position, the buffet increases, airspeed decreases, and aircraft approaches a stall.

Section 5C—Traffic Pattern Stalls and Approach-to-Stall Training

5.22. Purpose:

5.22.1. The Air Force has lost many lives and aircraft due to traffic pattern accidents. In the T-38, it is particularly easy to put yourself into an unrecoverable stall or sink rate situation before the indicators get your attention.

5.22.2. Approach-to-stall/stall training in the working airspace develops a number of critical skills that can prevent catastrophe in the traffic pattern. Stall training keys on the important areas of recognition and recovery. Approach-to-stall training is not a precise maneuver. It is designed to teach stall recognition and stall recovery. Although approach-to-stall training simulates conditions that may arise in the traffic pattern, this training is applicable to all phases of a T-38 mission. Use varying flap settings. Note the less defined onset of the increased buffet at lower flap settings. There will be a greater possibility for a secondary stall during no-flap approach-to-stall training.

5.23. Turning Approach-to-Stall Exercise. Establish the landing configuration, set the power (80 percent rpm minimum), and fly a simulated final turn with an intentional error. Possible errors include a level, diving, or overshot final turn. For the level final turn, maintain a fairly constant bank angle and allow the airspeed to decrease until reaching the definite increase in buffet intensity. For errors in other than the level final turn, progressively increase the bank and back stick pressure. For any of the above examples, as you detect a definite increase in buffet intensity, execute a stall recovery.

5.24. Landing Attitude Approach-to-Stall Exercise. Establish the landing configuration, set the power (80 percent rpm minimum), attain a landing attitude, simulate stretching the glidepath to a landing (the consequence of a poorly flown pattern), and allow the airspeed to decrease. As you detect a definite increase in buffet intensity, execute a stall recovery. Use greater finesse to recover due to the slow stall speed in a wings-level situation.

5.25. Stall and Approach-to-Stall Recovery Completion. Recovery is complete when the descent is stopped, positive controlled climb is established (altimeter and VVI reversed), and aircraft has sufficient airspeed for continued flight.

Section 5D—Abnormal Flight Recoveries

5.26. Purpose. You may find yourself in a flight attitude where loss of aircraft control is imminent unless you initiate a proper recovery. Although the recoveries indicated in **paragraph 5.27** and **paragraph 5.28** might seem quite simple, the events leading up to them can result in confusion or disorientation that would severely hamper your recovery efforts.

5.27. Nose-High Recovery:

5.27.1. Use a nose-high recovery to return to level flight following an unrecognizable or potentially unsafe nose-high attitude. Choose a recovery technique commensurate with the severity of the nose-high attitude. Make any required power increases smoothly to prevent engine compressor stalls and/or flameouts.

5.27.2. Some instances, such as *moderate* pitch attitudes or near wings-level attitudes, may simply require relaxing back stick pressure and maintaining slight G forces while recovering to level flight. However, *extreme* pitch attitudes may require rolling toward the nearest horizon and pulling the nose down to a level-flight attitude. In addition, extremely low airspeeds may require an unloaded recovery resembling the low-speed stability exercise.

5.27.3. With all of these techniques, if airspeed is sufficient as the nose approaches the horizon (approximately 230-265 KIAS depending on fuel weight), roll out and return to level flight. If airspeed is insufficient to comfortably maintain level flight as the nose passes the horizon, delay the rollout until the nose is definitely below the horizon and continue to accelerate in a slight descent until you can return to level flight.

5.28. Nose-Low Recovery:

5.28.1. Use a nose-low recovery to return to level flight or a slight climb following an unrecognizable or potentially unsafe nose-low attitude in the minimum turn radius. The minimum turn radius is achieved by maintaining the aircraft at the aerodynamic or G-limit between approximately 250 knots and corner velocity (approximately 400 knots). To achieve this, quickly roll the aircraft to the nearest horizon and apply back stick pressure to achieve the moderate buffet or desired recover G (whichever comes first). Normally, 4 to 5 Gs are sufficient for an expeditious recovery in the working airspace. In a nose-low recovery situation where proximity to the ground is a concern, do not hesitate to pull to the aerodynamic/G limit of the aircraft.

5.28.2. Adjust power and/or speed brakes to maintain the airspeed between approximately 250 and 400 knots. The "feel" of the aircraft may be used to help analyze airspeed. If the aircraft is at the desired G-limit and no buffet is felt, reduce the airspeed to minimize the turn radius. If a moderate buffet is felt prior to reaching the desired G, set the power to at least MIL until the buffet begins to go away at the desired recovery G.

Section 5E—Aerobatic Maneuvers

5.29. Purpose. Aerobatic maneuvers exploit the maneuvering envelope of the aircraft, develop skills required to smoothly fly the aircraft throughout a variety of defined parameters, improve energy management skills, and build three-dimensional situational awareness (SA). As contact maneuvers, aerobatics require a disciplined composite cross-check, using references inside and outside the cockpit. For example, airspeed, altitude, and G-loading must be verified inside the cockpit; clearing and ground track control must be accomplished using outside references; and attitude and area orientation usually require both inside and outside references. When available, use outside references to enhance clearing and maneuver precision.

5.30. Aerodynamic Parameters. Entry parameters for each maneuver are summarized in **Table 5.1** Fly all aerobatic maneuvers, using the range of airspeeds and power settings within specified post-proficiency parameters. Remain in visual meteorological conditions (VMC) during aerobatic maneuvering. **(T-1)**

Table 5.1. Summary of Entry Parameters for Aerobatics.

ITEM	A	B	C
	Maneuver Proficiency	**Airspeed**	**Power Setting**
1	Lazy Eight	350 KIAS	95 percent rpm
2	Barrel Roll	400 KIAS	
3	Loop	500 KIAS	MIL power
4	Split-S	200 KIAS	
5	Immelmann	500 KIAS	
6	Cuban Eight		
7	Cloverleaf	450 KIAS	
8	Chandelle	400 KIAS	95 percent rpm
Post-Proficiency			

9	Lazy Eight	300 to 400 KIAS	90 percent rpm – MIL power
10	Barrel Roll	300 to 500 KIAS	
11	Loop	450 to 500 KIAS	550 degrees EGT MIL power
12	Split-S	Approximately 200 KIAS	90 percent rpm MIL power
13	Immelmann	450 to 500 KIAS	550 degrees EGT – MIL power
14	Cuban Eight		
15	Cloverleaf	400 to 500 KIAS	550 degrees EGT MIL power
16	Chandelle	350 to 450 KIAS	90 percent rpm MIL power

5.31. Factors Affecting Aerobatic Maneuvers in the Vertical. Several factors work together to affect the altitude required to complete over-the-top or split-S-type maneuvers. They are entry airspeed, power setting, aircraft weight, and pilot technique. The following are some general rules of thumb that apply when flying aerobatic maneuvers:

5.31.1. Turn radius depends on G-loading and airspeed.

5.31.2. Holding other parameters constant, higher G-loading reduces the altitude required to complete the maneuver, while higher airspeed increases the altitude required.

5.31.3. Higher power settings improve turn performance at low airspeeds. Thrust offsets the higher induced drag present under higher AOA, thus preserving airspeed (and, therefore, G available). In contrast, a lower power setting combined with high-induced drag degrades the ability to acquire or sustain G available. Combinations of these variables can cause up to a 2,000 to 3,000 feet difference in altitude required for an over-the-top maneuver.

5.31.4. As a guide, plan for at least 10,000 feet when accomplishing aerobatics in the vertical plane (over-the-top and split-S-type maneuvers).

5.32. Energy and Airspace Requirements:

5.32.1. **Table 5.2** shows distances from the start of the actual maneuver to completion of the maneuver. Theses distances do not include any airspace used in setting up the maneuver or any airspace used to perform the flyout following the maneuver.

Table 5.2. Airspace Requirements.

ITEM	A	B	C
	Maneuver	**Lateral Distance Required**	**Altitude Required**
1	Lazy Eight	2 nm forward; 6 nm in direction of turns	4,000 to 6,000 feet above
2	Barrel Roll	3 nm forward	4,000 to 8,000 feet above
3	Loop	1 to 2 nm forward	8,000 to 10,000 feet above
4	Split S	1 nm forward; 1 nm behind	7,000 to 10,000 feet below
5	Immelmann	1 nm forward	

6	Cuban Eight	1 nm forward; 2 nm behind	8,000 to 10,000 feet above
7	Cloverleaf	3 nm forward; 2 nm in direction of first turn; 3 nm opposite direction of first turn	
8	Chandelle	1 nm forward; 1 nm in direction of turn	6,000 to 7,000 feet above

5.32.2. Entering an over-the-top maneuver involves flying the aircraft to a point where entry parameters can be reached with sufficient airspace above or below required to complete the maneuver. First of all, the overall energy level must be assessed and adjusted, if required, to meet entry parameters. Techniques for making this assessment were discussed in **paragraph 5.3** Once the desired energy level has been attained, the aircraft must be flown to an altitude that permits starting the maneuver. If this involves a descent, one technique is to lead the pullout by 10 knots and/or 500 feet for each 10 degree nose-low (for example, for 50 degrees nose-low, lead the pullout by approximately 50 knots and/or 2,500 feet).

5.32.3. Energy can be affected by how the maneuver is flown. Low energy can be affected in one of two ways. First, if airspeed is relatively high, but altitude is low, fly the first portion of the over-the-top maneuver, using 4 to 4.5 Gs (vertical airspace permitting). Then use the light tickle and "float" the upper portion of the pull. This technique may offer the opportunity to gain energy during the loop. If airspeed is low (regardless of altitude), pull closer to 5 Gs initially to make it over the top with greater than the minimum over-the-top airspeed of 150 KIAS. This should allow you to complete the loop; however, this technique may result in an overall energy loss. High energy can easily be reduced by increasing induced drag (higher AOA/G-loading) during the maneuver.

5.33. Aileron Roll. Aileron rolls can be performed at any airspeed and at various pitch attitudes. Because the T-38 is capable of an extremely high roll rate, relax control pressure during the last part of the roll to prevent overshooting the wings-level attitude. Stay smooth and do not attempt to keep the nose on a point.

5.34. Lazy Eight:

5.34.1. Pre-proficiency entry parameters are 350 KIAS, using 95 percent rpm. Post-proficiency entry parameters are 300 to 400 KIAS, using 90 percent rpm MIL power.

5.34.2. From straight-and-level flight, pick a point 90 degrees off the nose (in the direction of the first turn). Start a smooth, climbing turn in that direction so the nose describes an arc above the horizon, reaching the maximum pitch attitude at approximately 45 degrees of turn.

5.34.3. One technique is to drag the lower fire light across the horizon. The nose should then start back down, passing through the horizon after 90 degrees of turn with approximately 90 degrees of bank at approximately 200 knots. As the nose passes through the horizon, begin a smooth, gradual rollout and pullup, planning to reach the maximum nose-down pitch attitude after approximately 135 degrees of turn. At this point, the canopy bow should be on or near the horizon.

5.34.4. Complete the first half of the maneuver after approximately 180 degrees of turn in a wings-level flight attitude <u>with the entry airspeed</u>. Enter the second half of the maneuver by turning in the opposite direction. Complete the lazy eight with the aircraft headed in the original direction <u>at entry airspeed</u>.

5.34.5. The emphasis is on flying a smooth, symmetrical maneuver with constantly changing parameters. A power setting of 95 percent rpm maintains energy fairly well for all entry airspeeds. A higher power setting will allow larger leaves and/or a gain in energy.

5.34.6. A lazy eight will require approximately 2 nm forward, 6 nm to your right or left—in the direction of the turns—and 4,000 to 6,000 feet above.

5.35. Barrel Roll:

5.35.1. Pre-proficiency entry parameters are 400 KIAS using 95 percent rpm. Post-proficiency entry parameters are 300 to 500 KIAS, using 90 percent rpm MIL power.

5.35.2. The barrel roll is a coordinated roll in any direction in which the nose of the aircraft describes a circle around a point. Choose a point on or slightly above the horizon and maneuver the aircraft to attain entry parameters in a wings-level attitude with the aircraft 30 to 45 degrees to the side of the selected point. Begin a rolling pull in the desired direction and use smooth control inputs to maintain a circular flightpath around the reference point. You should be (1) in 90 degrees of bank directly above the selected reference point, (2) in a wings-level inverted attitude when passing abeam the reference point at 180 degrees of roll, (3) in 90 degrees of bank directly below the selected reference point, and (4) in a wings-level upright attitude when completing the maneuver.

5.35.3. Another technique is to begin the maneuver by choosing a desired roll axis from which the barrel roll will be flown. Offset this roll axis the number of degrees that defines the size of the roll (normally 30 to 45 degrees). Pick a point on the horizon twice the degrees of the offset in the desired direction of the roll. For example, if selecting a 45-degree offset, pick a point 90 degrees off the nose.

5.35.4. Begin a coordinated roll and pull to fly the nose of the aircraft to be inverted at the point. Continue the coordinated roll or pull to fly the aircraft back to the original offset heading. You should be at 90 degrees of bank as the nose of the aircraft passes the original roll axis (both on the first and second half of the roll), and the degrees nose high and low at these points are defined by the number of degrees of the original offset. The ending airspeed should be approximately the same as the entry airspeed for a symmetrically flown maneuver, but symmetry is more important than finishing at entry airspeed.

5.35.5. Maintain positive G-loading throughout the roll. To gain energy, use higher power settings and/or light G-loading.

5.35.6. A barrel roll will require a forward distance of approximately 3 nm and 4,000 to 8,000 feet above.

5.36. Loop:

5.36.1. Pre-proficiency entry parameters are 500 KIAS, using MIL power. Post-proficiency entry parameters are 450 to 500 KIAS, using 550 degrees EGT MIL power.

5.36.2. Begin the loop with entry airspeed and approximately 10,000 feet of altitude above you. Smoothly apply back stick pressure until reaching approximately 4.5 to 5 Gs (referencing the accelerometer as necessary) in a straight pull. Continue to increase back stick pressure to maintain the tickle or AOA “green donut.” Ensure wings are level when passing through the horizon inverted. Maintain back stick pressure to keep that tickle as Gs build to approximately

4 to 5 on the bottom side of the loop. Finish the maneuver in level flight at entry parameters, unless flowing immediately into another maneuver.

5.36.3. A loop will require approximately 1 to 2 nm forward and 8,000 to 10,000 feet above you from the start of the pull until maneuver completion. This does not include airspace used to set the maneuver up or post-loop maneuvering.

5.37. Split-S:

5.37.1. Pre-proficiency entry parameters are 200 KIAS, using MIL rpm. Post-proficiency entry parameters are approximately 200 KIAS, using 90 percent rpm MIL power.

5.37.2. The split-S is essentially the last half of a loop. Enter the split-S from a slight climb to ensure completion of the roll to the wings-level inverted attitude before the nose reaches the horizon. Once inverted, neutralize the ailerons and increase back stick pressure to attain light buffet in a straight pull. Maintain the light buffet until reaching the desired G-loading.

5.37.3. The maneuver is complete when you are wings level approximately 180 degrees from entry heading. A split-S requires approximately 1 nm forward, 1 nm behind, and 7,000 to 10,000 feet below.

5.38. Immelmann:

5.38.1. Pre-proficiency entry parameters are 500 KIAS using MIL power. Post-proficiency entry parameters are 450 to 500 KIAS using 550 degrees EGT MIL power.

5.38.2. The Immelmann resembles the first half of a loop followed by a half roll at the top. Begin the Immelmann by using the same mechanics as a loop. Just prior to reaching the inverted, level-flight attitude (front cockpit reference—canopy bow on the horizon), relax back stick pressure and execute a half roll in either direction. Complete the maneuver in level flight 180 degrees from the original heading.

5.38.3. An Immelmann will require approximately 1 nm forward and 8,000 to 10,000 feet above.

5.39. Cuban Eight:

5.39.1. Pre-proficiency entry parameters are 500 KIAS, using MIL power. Post-proficiency entry parameters are 450 to 500 KIAS using 550 degrees EGT MIL power.

5.39.2. Begin the Cuban eight by using the same mechanics as a loop. Continue to pull through the inverted, level-flight attitude. As the aircraft approaches a 45-degree, nose-low inverted attitude, relax back stick pressure and execute a half roll in either direction. Keep the nose of the aircraft approximately 45 degrees below the horizon until beginning the next 4.5 to 5 G pullup. Do not allow the nose to drift up as airspeed increases.

5.39.3. To obtain entry airspeed for the second half of the maneuver, lead the pullup by approximately 50 knots (10 knots for each 10 degrees nose low). Repeat the entire maneuver, except at the 45-degree, nose-low inverted attitude, the direction of roll will be opposite that of the first roll. Complete the maneuver in level flight, at entry speed, and heading in the original direction.

5.39.4. A Cuban eight will require approximately 1 nm forward, 2 nm behind, and 8,000 to 10,000 feet above.

5.40. Cloverleaf:

5.40.1. Pre-proficiency entry parameters are 450 KIAS, using MIL power. Post-proficiency entry parameters are 400 to 500 KIAS using 550 degrees EGT MIL power.

5.40.2. A complete cloverleaf consists of four identical maneuvers ("leaves"), flown consecutively and in the same direction, with each entry heading 90 degrees from the previous one.

5.40.3. From level flight, choose a 90-degree reference point and then begin a 2 to 3 G pullup. Approaching 45 degrees of pitch, begin a slow, rolling pull to lay the aircraft on its back at your selected 90-degree reference point. The airspeed should be between 175 to 200 KIAS as the aircraft passes through the inverted, level-flight attitude.

5.40.4. The pullout part of each "leaf" resembles a split-S. Smoothly increase back stick pressure to maintain the light buffet as the Gs increase. After passing the nose-low, vertical position, adjust back stick pressure to arrive at the level-flight attitude <u>with entry airspeed</u>. Continue the maneuver by starting the next "leaf."

5.40.5. A cloverleaf will require approximately 3 nm forward, 2 nm in the direction of the first turn, 3 nm opposite the direction of the first turn, and 8,000 to 10,000 feet above. **Note:** Because most of a cloverleaf will be away from your first turn, you should turn into the closest border for the first leaf.

5.41. Chandelle:

5.41.1. Pre-proficiency entry parameters are 400 KIAS, using 95 percent rpm. Post-proficiency entry parameters are 350 to 450 KIAS using 90 percent rpm MIL power.

5.41.2. The chandelle is a steep, climbing turn of approximately 180 degrees with maximum altitude gain for a given power setting and entry airspeed. The maneuver involves constantly changing your altitude, airspeed, and nose track; the altitude is always increasing and the airspeed is always decreasing.

5.41.3. Begin on parameters, with the nose below the horizon. Start a climbing turn so the nose of the aircraft passes through the horizon after 30 to 45 degrees of turn with approximately 60 degrees of bank. The nose of the aircraft should continue to rise at a constant rate and describe a straight line diagonal to the horizon.

5.41.4. Hold the bank constant, using top aileron and/or rudder as necessary, until approximately 135 to 150 degrees of turn. At this point, continue the nose track and start decreasing the bank angle to complete the maneuver with the wings level (not level flight) at approximately 200 KIAS and 180 degrees of turn. The lower the nose at the beginning, the higher it will be at the end, and vice versa. For example, if you enter at 15 degree nose-low, you will finish at approximately 45 degrees nose-high. If you enter at 20 degrees nose-low, you will finish at approximately 60 degrees nose-high.

5.41.5. A chandelle will require approximately 1 nm forward, 1 nm in the direction of the turn, and 6,000 to 7,000 feet above.

Chapter 6

FORMATION

Section 6A—Formation Administration

6.1. Introduction. The purpose of flying formation is to provide the mutual support required to accomplish a given mission. Whether the mission is air superiority, interdiction, or close air support, mutual support is essential for mission accomplishment. Procedures used in formation typically remain the same whether in two-ship or larger formations. Differences in procedures will be highlighted throughout this chapter.

6.2. Responsibilities:

6.2.1. Flight Lead. The flight lead is ultimately responsible for the safe and effective conduct of the mission. He or she plans, briefs, and debriefs the flight. This position gives both the authority and the responsibility to ensure the flight proceeds as intended. Lead must concentrate efforts on accomplishing the mission, achieving objectives, and returning with the flight intact. He or she must consider the capabilities of the wingman in planning a sortie. Taking this into consideration, lead should optimize training for all flight members and plan missions accordingly, to include briefing mission-specific parameters.

6.2.1.1. Nav Lead. This may be used when lead wants the wingman to navigate and clear. The flight lead will fly the wingman position, deconflict within the flight, and keep the radios (for example, battle damage [BD] check).

6.2.1.2. Admin Lead. This is used to pass lead responsibilities to another member of the flight. The admin lead is expected to run all aspects of the profile to include navigating, managing radios, and making changes to the profile if external conditions dictate. With an admin lead change, the call signs within the flight are administratively renumbered to match the position being flown. However, the flight lead still retains ultimate authority for the formation.

6.2.1.3. Tactical Lead. This may be used when the flight lead needs the wingman to lead an event (for example, fighting wing) or segment of the flight. In this case, the wingman picks up tactical, navigation, and radio responsibilities, but not overall flight leadership responsibility. Individual call signs do not change.

6.2.2. Wingmen. Commensurate with their skill, wingmen will be tasked to achieve the mission. Tasks include mission planning, threat study, and providing information in the brief. Once airborne, each wingman must execute the plan as briefed. Whether the flight is taxiing out to the runway or flying up initial, the wingman must look and sound good, match lead's configuration, and always anticipate but never assume. To contribute successfully, wingmen must prioritize the following responsibilities:

6.2.2.1. First and foremost, CLEAR! (Deconflict from lead, the ground, and other aircraft.)

6.2.2.2. Maintain visual with lead and other aircraft in the flight, as applicable.

6.2.2.3. Maintain proper formation position (as briefed or IAW published guidance).

6.2.2.4. Accomplish cockpit tasks (radio channel changes, ops checks, NAVAIDs, etc.).

6.2.2.5. Accomplish mission tasks (area orientation, route timing, target identification, etc.).

6.2.2.6. Strive to maintain high SA.

6.2.3. Flight Discipline. The effectiveness of a formation mission is highly dependent on solid flight discipline, which begins with mission preparation and continues through briefing, ground operations, flight, and debrief. Mission effectiveness requires an in-depth knowledge of flight rules, unit standards, and procedures. Lead establishes the precedent, and his or her orders must be followed. However, the wingman must speak up rather than allow the flight to enter an unsafe or unauthorized situation. If directed tasks are beyond a wingman's ability, he or she must immediately inform lead. Uncompromising flight discipline is absolutely essential for successful mission execution.

6.2.4. Collision Avoidance. Each aircrew member shares the responsibility of avoiding a collision. The wingman retains primary responsibility for deconfliction between flight members. This responsibility transfers to lead if the wingman becomes padlocked, blind, or placed in a blind cone during maneuvering. If any conflict develops between flight members, they should take immediate action and then transmit their intentions as time permits (for example, "Reno 2 is going high"). They should also avoid attempting to direct other flight members because they may misunderstand or be unable to perform the directed course of action.

6.2.4.1. Lead. Flying in the lead position allows the most flexibility to clear visually for the flight while interpreting traffic calls from Air Traffic Control (ATC.) Lead should focus on avoiding traffic and maintaining a safe altitude above the ground. If a wingman becomes padlocked, blind, or placed in a blind cone during tactical maneuvering, lead will assume responsibility for intraflight deconfliction.

6.2.4.2. Wingman:

6.2.4.2.1. Normally, wingmen will ensure deconfliction. If any conflict exists between flight members, the wingman should maneuver predictably and then transmit his or her intentions, affording the other aircraft a means to deconflict. For example, the wingman will transmit, "Reno 2 is going low," while crossing lead's flightpath in a delayed turn nearly in-plane. The transmission indicates Reno 2 will be maneuvering below lead to remain well clear. Lead may then maneuver anywhere away from the wingman's predictable POM. This technique prevents an aircraft from directing a course of action the other aircraft may be unable to perform.

6.2.4.2.2. While maintaining position in formation, wingmen also have standard visual lookout responsibilities. If they discover a traffic conflict, they will initiate a directive call to eliminate any conflict. They will follow with a descriptive call to allow other flight members to acquire the traffic and maneuver appropriately ("Reno 21, climb, traffic, 12 o'clock, level, 1 mile"). Wingmen will also provide mutual support by maintaining SA through calls from controlling agencies describing the position of potential traffic conflicts.

6.2.5. Visual Lookout. All flight members share visual lookout responsibilities. Excellent visual lookout depends on the ability to focus--and refocus--the eyes at appropriate ranges throughout the flight. Lookout priorities can change at a minute's notice, depending on the mission, weather, threats, altitude, and formation. In tactical formation, lookout priorities may change based on the mission, weather, threat, altitude, formation, etc.

6.2.5.1. Lead. In addition to briefing visual lookout responsibilities, lead must clear in the direction of the flight, focusing on avoiding traffic and maintaining a safe altitude above the ground. While employing in a tactical formation, lead shares responsibility with wingmen to visually clear for threats and traffic conflicts.

6.2.5.2. Wingman. The wingman's primary job is to execute disciplined visual lookout without sacrificing proper formation position or deconfliction responsibilities. Emphasis on deconfliction is directly related to aircraft proximity. For example, in fingertip, deconfliction requires more attention than in route or tactical. Beyond fingertip, the wingman must carefully keep his or her visual lookout active and systematic, with an emphasis on deconflicting with other flight members. Visual lookout priorities should be briefed by lead.

6.2.5.3. Traffic Conflict. Anyone may initiate a directive call to eliminate any conflict. Follow up the directive call with a descriptive call to allow other flight members to acquire the traffic and maneuver appropriately (for example, "Scar 21, climb-traffic, your 12 o'clock, 1 mile, slightly low, or 360, 5 nm, slightly high").

6.2.6. Fuel Awareness:

6.2.6.1. All flight members must understand the factors to consider in determining joker and bingo fuel. Afterburner should not normally be used after reaching bingo fuel unless required for safety of flight. Flight members should increase their frequency of fuel checks during high fuel flow operations (for example, extended trail, fluid maneuvering, low altitude training). Lead must continually monitor the flight's fuel state and adjust the profile, frequency of ops checks, and joker or bingo, as necessary.

6.2.6.2. Unless already established on the return to base (RTB) phase of flight, wingmen will inform lead when reaching joker and bingo and receive an acknowledgment. If fuel drops below joker before informing lead, wingmen will reference the fuel state from bingo ("Reno 2 is bingo plus 1").

6.3. Radio Discipline and Procedures. Communications are a good indicator of flight discipline. All radio calls to the flight as a whole or to an outside agency should begin with the full call sign ("Reno 21, 90 left"). Voice recognition is often a significant factor in tactical operations, but it should not be relied upon for primary identification or communications. Intraflight radio calls to a specific position should reference that position ("Flank 2, break out"). Wingmen should acknowledge "go" frequency changes with call sign or position (e.g., "Chevy 21, go channel 4."; acknowledgments: "2, 3, 4.") They should not acknowledge frequency changes initiated with "push."

6.3.1. Lead. Ensure radio calls are clear and concise and combine calls when practical. Based on wingman proficiency and/or flight conditions, widen the formation for frequency changes or delay flight check-in as necessary.

6.3.2. Wingmen. Change radio frequencies only when directed by lead. When performing a channel change, maintain your formation position unless otherwise prescribed or briefed. To minimize head-down time, count clicks while rotating the selectors and then confirm proper mode and frequency. Mimic the format of lead's calls, but provide accurate information. For example, if lead says, "Reno 21, ops check," and "1 is 2.3, 5 Gs," the wingman will say, "2 is 2.1, 4.5 Gs." (**Note:** Unless briefed, when communicating with other agencies, lead will speak for the flight until it splits up.) Wingmen will normally respond to all directive calls, unless briefed otherwise or the action is obvious. If calls are unclear, the wingman will query lead.

6.4. Visual Signals:

6.4.1. When using visual signals, refer to AFPAM 11-205, *Aircrew Quick Reference to Aircraft Cockpit and Formation Flight Signals*, to the maximum extent possible. Brief any nonstandard visual signals. Do not hesitate to use the radio to avoid confusion. To minimize confusion, only the pilot at the controls should give visual signals to another aircraft in the formation. Visual signals must be clear and appropriate for range (for example, a slight wing-rock to reform from route versus a large wing-rock from tactical).

6.4.2. Wingmen should acknowledge all visual signals. This acknowledgment may take the form of a head nod, thumbs-up, or change in formation position as appropriate. To minimize confusion, lead will make his or her head nod big and clear. If a wingman does not acknowledge a signal, it should be interpreted as a request for clarification. Repeat the signal or make a radio call. Pass visual signals down the line, if appropriate.

6.5. In-Flight Checks. Each flight member must accomplish required checks. Visual signals or radio calls from lead may be used to initiate required checks for the appropriate phase of flight Wingmen should be given an appropriate amount of time to complete in-flight checks. Lead should adjust the formation position if necessary, based on wingmen's skill level. Lead should also avoid any abrupt maneuvering to afford wingmen time to accomplish cockpit tasks without compromising deconfliction abilities. While performing in-flight checks, wingmen will continue to prioritize their attention on lead, using only short glances to perform cockpit duties.

6.5.1. Ops Check. When conducting ops checks on the radio, if lead says, "Reno 21, ops check, 1 is 2.3, 5.5 Gs," the wingman will say, "2 is 2.2, 5.8 Gs." Upon completion of ops checks following high-G maneuvering (> 4 Gs), pilots may reset their G-meter. Due to increased malfunctions with primary flight instrumentation, recommend verifying the correct orientation of the primary and standby ADIs during every ops check.

6.5.2. Fire control, Emitters, NAVAIDs, Communications, and Electronic countermeasures (FENCE) Check. "FENCE-in" is normally directed by lead upon entering the working airspace or route. Items to accomplish will vary with the mission type. As a minimum, check fuels, set altimeter and NAVAIDs, check G-suit, and squawk. "FENCE-out" will normally be accomplished exiting the work airspace or route at lead's direction.

6.6. Lead Changes. Lead changes require a clear transfer of responsibilities from one flight member to another. During the lead change, both pilots must monitor the other aircraft to ensure separation is maintained.

6.6.1. When a lead change is done from a close formation, the designated wingman moves out and forward to ensure wingtip separation while focusing his or her primary attention on lead. The wingman accepts the lead after reaching lead's 3/9 line and assumes lead responsibilities.

6.6.2. Three-and four-ship lead changes will be accomplished over the radio, and the new lead will acknowledge. The old lead will assume wingman responsibilities. Unless changed by the new lead, the formation will remain in the formation the position change was initiated from. For example, if the position change was initiated from route, the flight will remain in route.

6.7. Ground Operations:

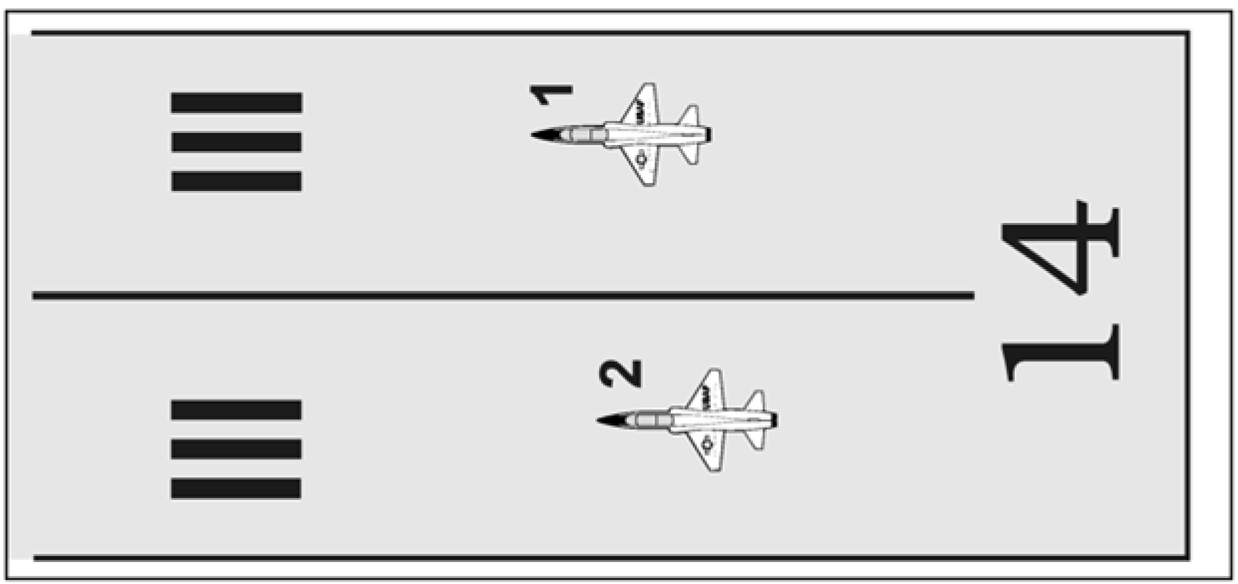
6.7.1. Chocks. Engine start and check-in procedures will be IAW unit standards or as briefed. If delays occur, inform lead as soon as possible, but not later than the briefed check-in time. If visual, pass a thumbs-up to lead when ready.

6.7.2. Taxi. Lead should taxi at a speed that allows wingmen to attain proper spacing. Wingmen will match lead's configuration, inspect each other for proper configuration and abnormalities prior to takeoff, and continue inspecting throughout the sortie.

6.7.3. Runway Lineup (Two- and Four-Ship). Runway lineup is normally determined by wind direction and other factors such as direction of turnout of traffic and weather. Lead will ensure wingmen have sufficient room to maneuver into position. Minimum wingtip spacing is 10 feet, but may be wider as desired or required. Lead will ensure 50 feet of wingtip spacing within an element if either crew is solo. On the runway, a head nod is used for visual signals instead of a thumbs-up.

6.7.3.1. Two-Ship. Lead will usually take the center of his or her half of the runway. The wingman will line up lead's main gear doors and take wingtip spacing as briefed (**Figure 6.1**) Once in position, the wingman will give lead a head nod to signal ready for engine runup.

Figure 6.1. Two-Ship Runway Lineup.

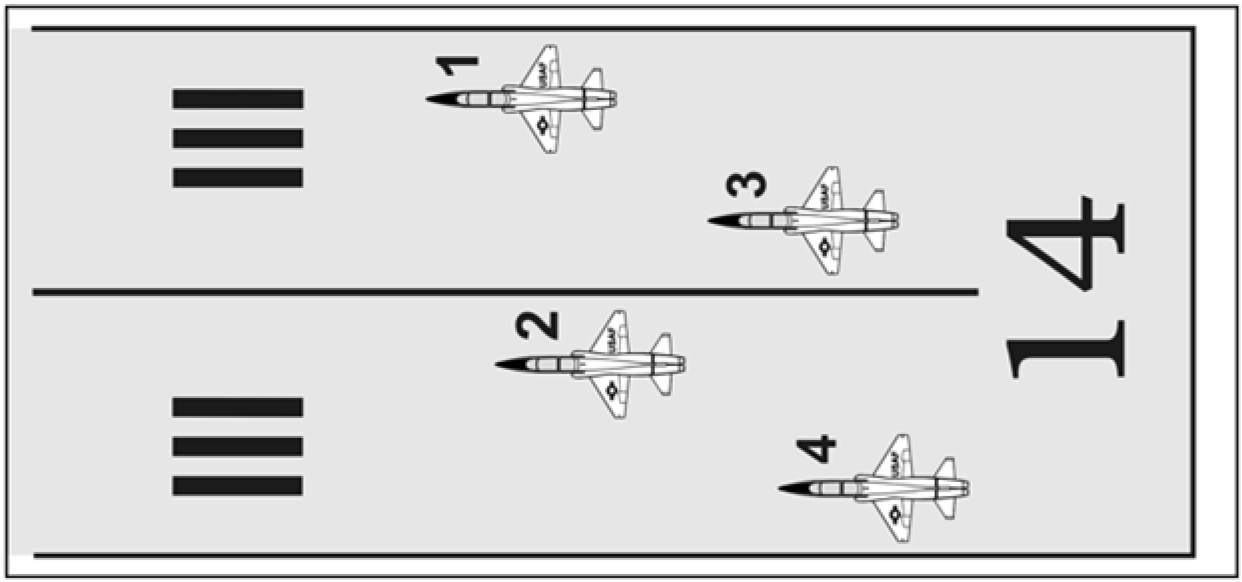


6.7.3.2. Four-Ship—Number 3 or 4 in the Slot. Lead should line up as far to the side of the runway as practical. Number 2 will place the wingtip closest to lead on the centerline and line up the gear doors.

6.7.3.2.1. Number 3 in the Slot (**Figure 6.2**) Number 3 will line up between lead and Number 2, maintaining nose-tail clearance out to 500 feet between elements. Number

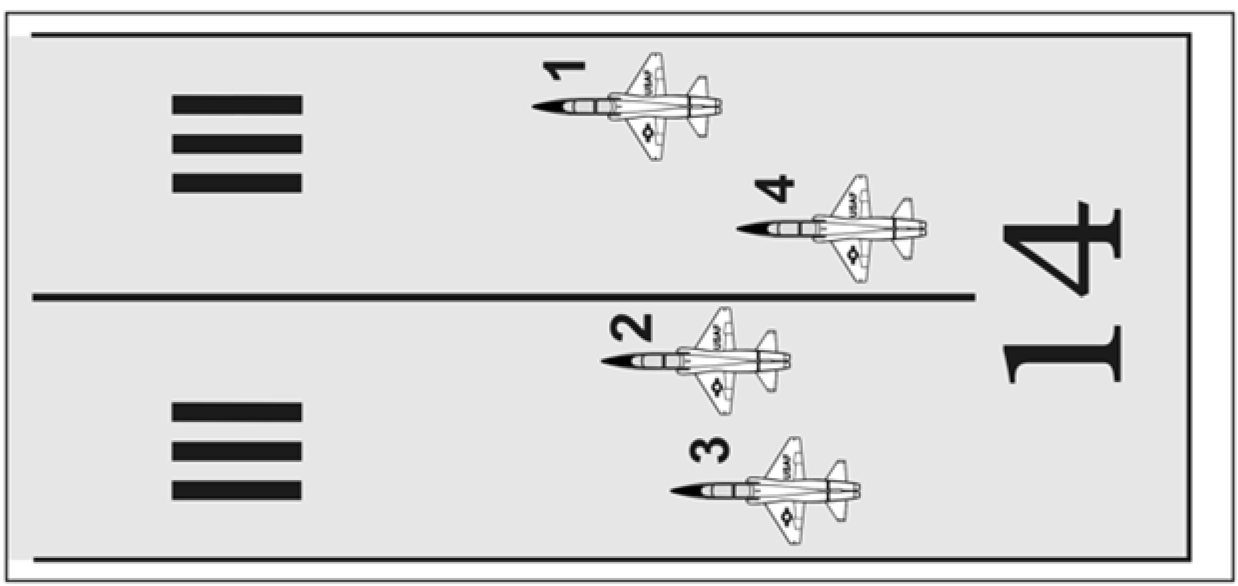
4 will line up offset from Number 2's jet blast while aligning the gear doors of Number 3.

Figure 6.2. Four-Ship Runway Lineup (Number 3 in the Slot).



6.7.3.2.2. Number 4 in the Slot (**Figure 6.3**) Number 3 will line up with wingtip clearance on Number 2 in echelon position. Number 4 will pull in between lead and Number 2 with wingtip clearance. Normally, Number 4 will pull forward to see Number 3's helmet over Number 2's saddleback.

Figure 6.3. Four-Ship Runway Lineup (Number 4 in the Slot).



6.7.3.2.3. Four-Ship Signals. Number 4 will use a head nod to signal ready for engine runup, and the signal will be relayed up the line (4—3—2—lead). Number 3 may need to relay the ready signal via the radio when the lead element is displaced down the runway.

6.7.3.3. Three-Ship. Three-ship formations may use any four-ship lineup as briefed or line up in echelon, if the runway is wide enough. **Note:** Always ensure 50 feet of wingtip spacing within an element if either crew is solo.

6.7.4. **Engine Runup.** Once all aircraft have signaled "ready," lead may direct runup visually or over the radio. During engine runup, continue to primarily focus attention outside the aircraft with only short glances inside the cockpit. Signal ready for takeoff with head nods up the line. If Number 3 is unable to see Number 2 for any reason, call "ready" after receiving Number 4's head nod.

6.7.5. **Formation Takeoff:**

6.7.5.1. Lead:

6.7.5.1.1. Once the power setting is established a helmet tap is the preparatory command for brake release and selecting MAX afterburner. The execution command is a head nod. As your chin hits your chest, simultaneously release brakes and select MAX. After ensuring both afterburners light, reduce power slightly on both engines to approximately 60 percent nozzles, but not less than minimum afterburner, do not adjust the throttles unless the wingman requests it. Use caution to prevent pulling the throttles out of afterburner. Retract the gear and flaps when you confirm the wingman is safely airborne. The visual signal for gear retraction is the gear doors opening. Begin a smooth power reduction out of MAX between 220 and 280 KIAS and terminate afterburner operation by 300 KIAS. Monitor the wingman throughout the takeoff.

6.7.5.2. Wingmen:

6.7.5.2.1. Monitor lead for the preparatory and execution signals. Release the brakes and advance the throttles to MAX afterburner when lead's chin hits his or her chest. Tap the brakes as required to maintain position initially. Confirm two good afterburner lights.

6.7.5.2.2. If a power advantage or disadvantage is apparent, request one increase or decrease in power (for example, "Snake 1, give me one/push it up"). Use caution to prevent pulling the throttles out of afterburner. If you cannot remain in position (either overrunning lead or falling behind) with power set between minimum and full afterburner, check both throttles in MAX, maintain separation from lead, and perform a separate takeoff.

6.7.5.2.3. Rotate with lead's aircraft and concentrate on maintaining a proper position. Normally, the first indication of lead's rotation will be the movement of the elevator or the extension of the nose-gear strut. Duplicate lead's pitch attitude for liftoff.

6.7.5.2.4. When both aircraft are airborne, maintain a stacked-level position until retracting the gear and flaps. The visual signal for gear retraction is lead's gear doors opening. Confirm the gear and flaps are retracted and then move into fingertip.

6.7.5.2.5. After takeoff, if you are ahead of lead, check slightly away from lead and resume flying off lead when able. Lead may pass the lead to you if conditions warrant.

6.7.5.3. **Interval Takeoff.**

6.7.5.3.1. When ready for takeoff, lead will release the brakes and perform a takeoff. Wingmen will delay brake release a minimum of 10 seconds for a single aircraft (15 seconds for an element takeoff) after the preceding aircraft. Single ships should steer toward the center of the runway after the start of the takeoff roll. To help expedite the rejoin, lead should terminate afterburner early (220 knots minimum), continue to accelerate to 300 KIAS, and climb at a reduced power setting (550 degrees EGT). If necessary, lead will coordinate for an intermediate leveloff to maintain VMC until wingmen are joined. Wingmen should delay coming out of afterburner until sufficient overtake is achieved. Unless briefed otherwise, flight members will rejoin to the position they are flying in the formation.

6.7.5.3.2. Rolling Interval Takeoff. When cleared for takeoff, lead will taxi into position and perform a normal single-ship rolling takeoff then follow the procedures above. After takeoff has been initiated by lead, wing will taxi into position and perform a normal single-ship rolling takeoff with a ***minimum of 10 seconds*** interval.

6.7.5.4. **Instrument Trail Departure:**

6.7.5.4.1. When flying an instrument trail departure, the first priority is to follow basic instrument flying procedures. Strictly adhere to the briefed climb speeds, power settings, altitudes, headings, and turn points. All aircraft will use 30 degrees of bank for all turns. Takeoff spacing will be no less than 20 seconds. Unless briefed otherwise, each aircraft or element will climb at 300 KIAS with 600 degrees EGT and maintain briefed spacing until all aircraft have reached VMC and are cleared to rejoin.

6.7.5.4.2. Until joinup, each pilot or element lead will call with altitude and heading when passing multiples of 5,000 feet and when initiating any altitude or heading change. Until visual contact, each pilot or element will maintain at least 1,000 feet of vertical separation from the preceding aircraft or element except where departure instructions specifically prohibit compliance.

6.7.5.4.3. If a visual joinup at leveloff is not possible, lead should request 1,000 feet of altitude separation for each succeeding aircraft or element. If 1,000 feet of separation prevents the wingmen from complying with the minimum safe altitude, lead may reduce the vertical separation to 500 feet. Wingmen will call visual on preceding aircraft and rejoin only after directed by lead.

6.8. Working Area or Route:

6.8.1. G-Awareness Exercise. Formation G warmup exercises should be flown from tactical line abreast or wall formations as described in **Section 6C**. Normally, two 180-degree turns will be performed for formation G-awareness exercises. Lead is responsible for planning the exercise to ensure 4,000 feet lateral separation for all formation members. Emphasis should be on the anti-G-straining maneuver, G-awareness, and correct operation of equipment, not on a perfect formation position.

6.8.2. Maneuvering Between Engagements. Following termination of fluid maneuvering (FM), basic fighter maneuvers (BFM), and air combat maneuvering engagements, wingmen should deconflict from and follow lead, select MIL, and climb or descend as necessary to obtain and climb at 350 KIAS. Obtaining a line abreast tactical formation is usually a secondary priority during the reset.

6.9. Knock-It-Off or Terminate:

6.9.1. Any flight member may initiate a knock-it-off or terminate. Make directive radio calls if danger is imminent. Call "knock-it-off" when safety of flight is a factor or where doubt or confusion exists. Call "terminate" when safety of flight is not a factor.

6.9.2. Aircraft with radio failure will signal knock-it-off with a continuous wing rock. Initiation of a knock-it-off or terminate will start with flight call sign, followed by each flight member transmitting his or her position number—in order—with "knock-it-off" or "terminate."

6.9.3. If any flight member fails to respond correctly, the sequence should be initiated again. For example, if anyone transmits, "Reno 21, knock-it-off," all flight members will respond as follows: "Reno 1, knock-it-off"; "Reno 2, knock-it-off"; "Reno 3, knock-it-off"; and "Reno 4, knock-it-off." When hearing a "knock-it-off" or "terminate" call or observing a continuous wing rock, all participating aircrew will clear the flightpath, cease tactical maneuvering, climb or descend to a prebriefed safe altitude (at least 1,000 feet AGL), and acknowledge with a call sign or wing rock. Lead will be directive before resuming maneuvers.

6.9.4. Transmit "knock-it-off" when any of the following situations occur:

6.9.4.1. A dangerous situation is developing.

6.9.4.2. SA is lost.

6.9.4.3. A violation of any of the following has occurred or appears imminent:

6.9.4.3.1. Area boundaries.

6.9.4.3.2. Minimum cloud separation.

6.9.4.3.3. Minimum altitude.

6.9.4.3.4. Or minimum range.

6.9.4.3.5. Weather is below minimums for the area or route.

6.9.4.4. Engaged aircraft exceeds maneuvering limits such that safety of flight is compromised.

6.9.4.5. A recognized radio failure or observation of a continuous wing rock.

6.9.4.6. Bingo fuel is inadvertently overflown and the fuel state requires traffic priority or direct routing to the primary or alternate recovery base.

6.9.4.7. An unbriefed or unscheduled flight enters the working area and is detrimental to the safe conduct of the mission.

6.9.4.8. Any player calls "knock-it-off."

6.9.5. Transmit "terminate" when any of the following situations occur:

6.9.5.1. Bingo fuel is reached.

6.9.5.2. The desired learning objective is achieved.

6.9.5.3. A stalemate is reached.

6.9.5.4. Any player calls "terminate."

6.10. Recovery:

6.10.1. BD Check:

6.10.1.1. Perform a BD check when directed by lead usually from either fingertip or route. The signal is either a radio call or a visual "check mark" signal. To perform the check, climb slightly to visually inspect the top of the near side of the aircraft. Continue the inspection by dropping down to inspect the lower side of the aircraft, perform a crossunder, and inspect the lower and upper side of the opposite side of the aircraft. Upon completion, remain on that side and assume the proper formation position. While inspecting the other aircraft, look for any damage, leaks, missing panels, or any irregularities.

6.10.1.2. During the BD check, the aircraft fulfilling lead responsibilities must clear for the formation while the wingman maintains deconfliction within the formation.

6.10.1.3. The wingman will use the radio to pass discrepancies; otherwise, he or she will pass a thumbs-up. Lead will then pass the lead to the wingman and perform a BD check. The lead change may be a nav lead change or an admin lead change, depending on the briefed profile.

6.10.1.4. For a three or four-ship BD check, lead will direct Number 2 to check the flight. All other aircraft will maintain position while Number 2 checks the entire formation and returns to the original position. When Number 2 is in position, Number 4 is automatically cleared to check Number 2.

6.10.2. Splitting the Flight. When splitting the flight becomes necessary, lead will verify that wingmen have a positive fix from which to navigate and coordinate with ATC for separate clearances.

6.10.3. Formation Approach and Landing. Lead will position the wingman on the upwind side of the runway if crosswinds are greater than 5 knots. Gear and full flaps are normally lowered with one visual signal or radio call unless briefed otherwise. Both pilots should check their own aircraft and the other aircraft and then pass a thumbs-up if all indications are normal.

6.10.3.1. Lead. After confirming a safe gear indication for both aircraft, transmit a "gear down" call for the flight. After reaching VMC and being able to maintain visual contact with the runway on short final, line up with the center of the appropriate side and establish an aim point that will allow a touchdown approximately 500 feet to 1,000 feet beyond the threshold. Unless one aircraft will circle, fly the final approach airspeed for the heaviest aircraft. If one aircraft will circle from the approach, you have two options for configuration and airspeed: (1) sixty percent flaps and final turn airspeed or (2) full flaps and final approach airspeed. Regardless of the option you choose, the circling aircraft will have 60-percent flaps and a minimum of final turn airspeed before commencing the circling maneuver.

6.10.3.2. Wingman:

6.10.3.2.1. Fly normal fingertip references until on glidepath. Assume the "stack level" position when VMC on glidepath, as briefed or when directed. The vertical reference for stacking level is to place the helmet of the front cockpit pilot in the lead aircraft on the horizon. Your fore or aft position remains essentially the same as it is in fingertip (head abeam the slab bolt). Lateral spacing ranging from 10 feet to 50 feet wingtip clearance should be adequate in all cases, provided lead lands near the center of his or her side of the runway.

6.10.3.2.2. Attempt to stabilize at a given spacing in the 10 to 50-foot range, as briefed or as directed by other guidance (syllabus or unit standards). See **Table 6.1** for front and rear cockpit references for wingtip clearances of 10 feet, 25 feet, and 50 feet.

Table 6.1. Spacing References in the Stack Level Position.

ITEM	A	B	C
	Wingtip Clearance	**Front Cockpit**	**Rear Cockpit**
1	10 feet	Head abeam the slab bolt. Position light slightly forward of the leading edge of the gear door.	Abeam the aft edge of the burner cans. Look straight down the wing line.
2	25 feet	Head abeam the slab bolt. Position light in the center of the gear door.	Abeam the aft edge of the burner cans. Position light slightly forward of the leading edge of the gear door.
3	50 feet	Head abeam the slab bolt. Position light aligned with the trailing edge of the gear door.	Abeam the aft edge of the burner cans. Position light in the center of the gear door.

6.10.3.2.3. Focus on lead as the primary reference for the wing landing. Cross-check the runway on short final to ensure proper alignment and then fly the proper position off lead throughout the flare and touchdown. Once on the runway, maintain lateral spacing and use normal braking techniques.

6.10.3.2.4. After establishing nose-tail separation and under control, clear to the cold side of the runway. If landing on the cold side of the runway, turn off the landing light to clear lead to the cold side.

6.10.3.2.5. If you overrun lead, accept the overrun and maintain the appropriate side of the runway. The most important consideration is wingtip clearance. (Lead may pass the lead over the radio, if conditions warrant.)

6.10.4. Formation VMC Drag. These procedures may be used to achieve minimum runway separation of 3,000 feet between aircraft in formation when conditions prevent accomplishing a wing landing or visual flight rules (VFR) traffic pattern and landing. Lead will direct the wingman to drag according to local procedures and the following:

6.10.4.1. When in VMC at approximately 10 miles from the runway, lead will direct the drag.

6.10.4.2. The wingman will set 80 percent, select gear and full flaps below 240 KIAS, slow to final approach speed, and squawk appropriately.

6.10.4.3. Lead will maintain 220 to 240 KIAS until approaching the final approach fix (FAF) or glideslope intercept, configure with landing gear and full flaps, slow to and maintain 180 KIAS until approximately 3 mile final, and then slow to final approach speed.

6.10.5. Traffic Pattern:

6.10.5.1. Once established in the VFR overhead traffic pattern, turns away from the wingman will normally be in echelon. On or before turning initial, lead should place the wingman on the side opposite the direction of the break. Initial is usually flown in route or fingertip formation; tactical initial may be flown IAW local guidance.

6.10.5.2. Lead should break at the beginning of the break zone. After lead breaks, wingmen will delay 5 seconds before initiating the break and roll out on downwind slightly outside of lead. This normally provides a minimum of 3,000 feet spacing. If greater spacing is required, the wingman will delay the break. (Eight seconds normally provides 6,000 feet of spacing.) When approaching the perch point, wingmen will cross-check the runway and lead to ensure proper spacing from both.

6.10.5.3. In a four-ship, lead and Number 2 should avoid slowing so rapidly that trailing wingmen cannot maintain sufficient spacing.

Section 6B—Basic Formations

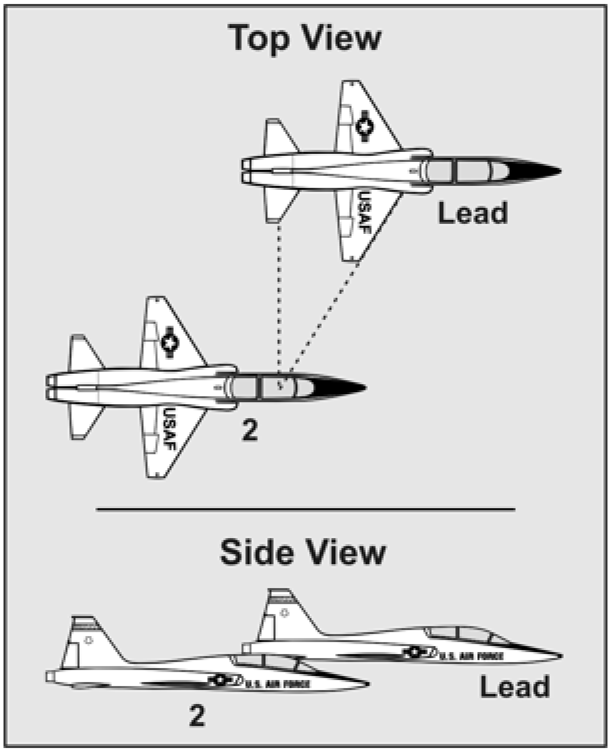
6.11. Fingertip Formation:

6.11.1. A fingertip formation (**Figure 6.4**) is used for weather penetration, airfield arrivals and departures, and show formations. The wingmen will maintain wingtip clearance while flying a position from which the front cockpit pilot looks down the leading edge of the wing. Positioning the front cockpit pilot's helmet abeam the slab bolt provides approximately 3 feet of wingtip separation. From the rear cockpit, lining up the position light with a point on the intake halfway between the wing root and the lower leading edge of the intake (with head abeam the trailing edge of the burner cans) provides 3 feet of wingtip clearance.

6.11.2. For a fingertip exercise, fly a series of modified lazy eight-type maneuvers, using up to 3 Gs and 90 degrees of bank in an airspeed range of approximately 200 to 400 KIAS. Lead will emphasize clearing, smoothness, and providing a stable platform with consistent, predictable roll rates and no sudden changes in back stick pressure. The wingmen will use small throttle or stick movements and trim to maintain position, while avoiding the tendency to stare at any one spot. Practice using all of lead's aircraft as a reference.

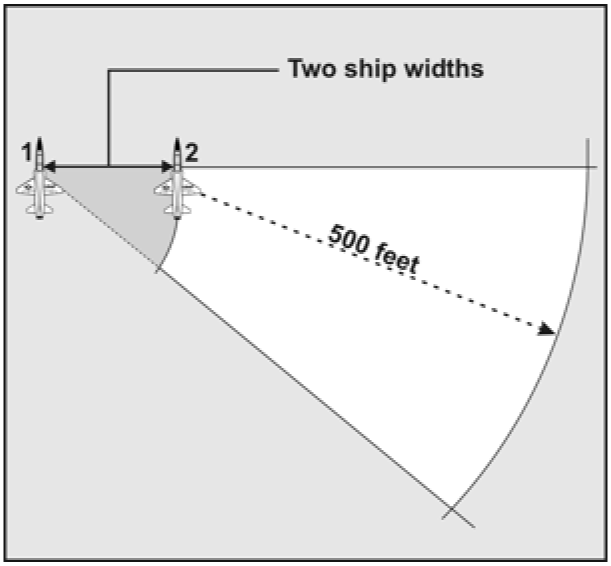
6.11.3. When flying fingertip in a three or four-ship formation, there is no difference for Numbers 2 and 3. Number 4 will fly the normal fingertip position and try to line up the helmets of Numbers 1 and 3. When Number 3 is adjusting, Number 4 should consider flying a stable position off Number 1 while monitoring and maintaining lateral separation from Number 3.

Figure 6.4. Fingertip Formation.



6.12. Route Formation. A route formation (**Figure 6.5**) is flown to enhance clearing and visual lookout, increase flight maneuverability, and ease the completion of in-flight checks, radio changes, and other cockpit tasks. Lead will send wingmen to route with a radio call or visual signal. Route is flown from two ship widths of spacing out to approximately 500 feet. Fly no farther aft than the extended fingertip line, no farther forward than line abreast, and, when wings level, maintain a level stack. On the inside of a turn, stack below lead's POM only as necessary to keep lead in sight. On the outside of a turn, maintain the same vertical references used in echelon. In a three or four-ship formation, Number 2 sets lateral spacing for the formation. Number 3 should fly line abreast with Number 2, matching lateral spacing from Number 1. Number 4 should line up the helmets of Numbers 3 and 1. Lead should limit the bank to 60 degrees bank with wingmen in route.

Figure 6.5. Route Formation.



6.13. Chase. Chase is used for a variety of reasons, including performance assessment and assistance during an emergency. Chase is flown IAW AFMAN 11-2T-38, Volume 3. Chase observers will maneuver in a 30 to 60-degree aspect cone out to 1,000 feet. Below 1,000 feet AGL, chase pilots will stack no lower than the aircraft being chased, and in no case will they fly below 300 feet AGL. The chase pilot is primarily responsible for aircraft separation.

6.14. Spread. Spread formation is used primarily as a navigation formation. It allows wingmen to devote more attention to such tasks as clearing visually and in-flight checks. Spread is flown with 1,000 to 3,000 feet between aircraft with the wingman line abreast to 30 degrees aft. The visual signal to move to spread is an outward pushing motion by lead's hand. In turns, wingmen should maintain their side of the formation unless lead calls a fluid turn. In two-ship spread formations, when lead calls "fluid" the wingman may maneuver as necessary to include crossing lead's 6 o'clock.

6.15. Echelon:

6.15.1. Echelon is a multiship formation where all wingmen are on the same side of the formation. Lead directs the flight into echelon by dipping a wing in the desired direction or making a radio call ("Sting 21, echelon left/right"). In two-ship formations, the formation is prepared for an echelon turn during fingertip or route.

6.15.2. Unless prebriefed (like turns in the VFR overhead pattern), lead normally directs an echelon turn (**Figure 6.6**) with a radio call or visual signal for two or three-ship formations. In a four-ship formation, an echelon turn is implied when the wingmen are on the same side. All aircraft must be very aware of the importance of smooth corrections and positive back stick pressure and the need to avoid unloading while in the turn.

Figure 6.6. Echelon Turn.

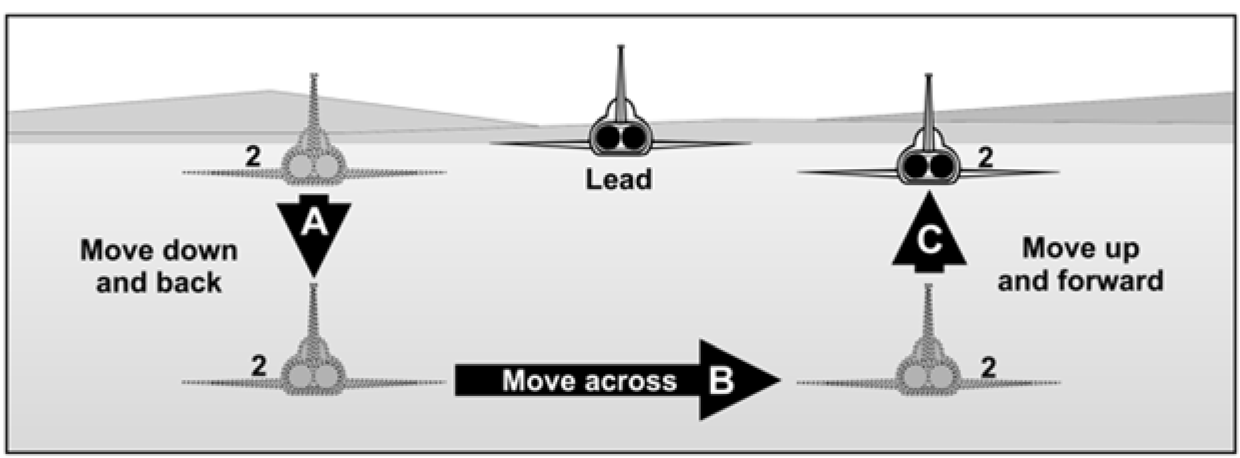
6.15.3. Except for very gentle turns into the echelon, always turn away from the echelon and plan to limit bank to 60 degrees maximum. Number 2 should match lead's roll rates. Once established in a turn, the horizon should split lead's lower intake. As in fingertip, the front copilot's helmet should be abeam the slab bolt. Use power to make fore or aft corrections, back stick pressure to maintain horizontal spacing, and bank to make corrections up or down.

6.15.4. When you are in the Number 3 or 4 position, the basic references are the same as those for Number 2. However, you should add lead's position in relation to the horizon to your cross-check so you do not overadjust for every correction Number 2 (or 3) makes. Echelon turns can be performed at a variety of airspeeds.

6.16. Crossunder:

6.16.1. Two-Ship Crossunder. Except for prebriefed events (like the BD check), lead normally directs a crossunder (**Figure 6.7**) with a radio call or visual signal. When using a wing dip signal, the size of lead's signal should be appropriate for the distance to the wingman. On lead's signal, the wingman will reduce power as required until a small forward line of sight (LOS) rate develops. The wingman will move back and down below lead's POM and add power to stop lead's forward LOS. He or she will then move across and behind lead with a minimum of nose-tail clearance, adding power as required so as not to fall any further behind. Once on the opposite side and with wingtip clearance, the wingman will add power to move up and forward into position.

Figure 6.7. Crossunder.



6.16.2. Four-Ship Fingertip Crossunder. In a four-ship basic formation, a wing dip toward Number 2 signals a crossunder for Numbers 3 and 4 and a wing dip toward Number 3 signals a crossunder for Number 2. If Number 2 is crossing to the side that Numbers 3 and 4 are on, Number 3 should smoothly move out to create room for Number 2. Number 2 begins a normal crossunder, but must ensure adequate spacing before crossing lead’s 6 o’clock. As Number 2 attains position, Number 3 begins flying off Number 2 while referencing lead. If Numbers 3 and 4 are crossing simultaneously, Number 3 begins smoothly dropping down and aft in a normal crossunder and establishes nose-tail clearance off Number 2 before crossing. As Number 3 begins the crossunder, Number 4 performs a crossunder on Number 3, normally crossing Number 3's 6 o’clock as Number 3 crosses behind lead. Number 4 must anticipate LOS rates and power changes to avoid falling aft.

6.16.3. Four-Ship Echelon Crossunder. In a four-ship echelon formation, lead's radio call or wing dip (always away from the echelon) directs the entire formation to change sides. Ideally, as Number 2 begins the crossunder, all the wingmen move together. The entire formation is in a straight line as the wingmen cross lead's 6 o'clock. Then all the wingmen assume their position on the other side of lead. A wing dip toward the echelon is meaningless. Any other formation change, like returning to fingertip, requires a radio call.

6.17. Pitchout:

6.17.1. The purpose of a pitchout is to provide spacing for a rejoin or follow-on maneuvering. After the signal or radio call, lead clears and then turns away from the wingmen, using G forces to attain 300 KIAS unless briefed or directed otherwise. Lead will normally fly a level turn of about 180 degrees. However, he or she may climb, descend, and/or adjust the degrees of turn as necessary for weather, area orientation, and/or energy management. Lead will allow enough time for the wingmen to complete the pitchout and then direct the rejoin with a radio call or visual signal.

6.17.2. Wingmen will keep lead or the leading aircraft in sight, delay 5 seconds or as briefed, and then turn to follow, using about the same bank angle and G-loading. A 5-second delay provides approximately 1 nm spacing. After turning approximately 90 degrees, the wingman will vary bank angle and back stick pressure as necessary to attain desired spacing. He or she will roll out behind and slightly below lead or the preceding aircraft, maintaining 300 KIAS until directed to rejoin.

6.18. Take Spacing:

6.18.1. Take spacing is normally used to increase range when reversing the direction of the flight is not practical (for example, practice rejoins). When these procedures are not specified in unit standards, they must be thoroughly prebriefed. They are VMC-only maneuvers.

6.18.2. Lead will direct the wingman to take spacing with a prebriefed visual signal or radio call. The wingman will acknowledge with a radio call or by maneuvering away from lead to take spacing. Spacing can be achieved with any combination of wingman maneuvers, wingman deceleration, and lead acceleration.

6.18.3. One technique is for lead to accelerate to 325 KIAS and direct the wingman to take spacing. Lead then selects MIL power and accelerates to 350 KIAS. The wingman selects idle and speed brakes, slows to 300 KIAS, and then calls “Sting 2’s ready” at the prebriefed range. Lead then selects idle and speed brakes, slows to 300 KIAS, and directs a rejoin as applicable.

6.18.4. Another technique, usually done at 300 KIAS, is for lead to direct the wingman to take spacing, which he or she does by performing a series of "S" turns behind and below lead's jetwash. When the desired spacing is achieved, the wingman calls "ready." If the plan is for a three or four-ship to take spacing, procedures for each aircraft should be thoroughly briefed.

6.19. Practice Lost Wingman Exercise. This exercise exposes new pilots to procedures that are critical during lost wingman scenarios in actual instrument meteorological conditions (IMC). (Practice this exercise in a two-ship formation in day VMC, using the procedures in AFMAN 11-2T-38, Volume 3.) Lead will initiate a practice lost wingman exercise with a radio call. He or she will acknowledge the wingman's "practice lost wingman" radio call by transmitting altitude, heading, airspeed, and other parameters, as appropriate. The wingman will execute the appropriate procedures, to include a radio call. The wingman may signify completion of the exercise (as determined and briefed by lead) by calling visual. NOTE: The IP or safety observer in the wing aircraft will monitor lead to ensure separation throughout the exercise.

6.20. Rejoins:

6.20.1. Overview:

6.20.1.1. The purpose of a rejoin is to get the flight back together safely and efficiently. Lead initiates rejoins with radio calls or visual signals and, when necessary for energy management or area orientation, may use slight climbs or descents during the rejoin. When lead cannot see the wingman, he or she will consider initiating the rejoin via a radio call.

6.20.1.2. Lead should monitor wingmen closely during all rejoins. Airspeeds and bank angles are normally prebriefed or unit standard. Lead should consider making a radio call if flying a different airspeed or bank angle.

6.20.1.3. For standard rejoins from positions other than tactical, lead will maintain 300 KIAS and 30 degrees of bank. For standard rejoins from tactical, lead will maintain 350 KIAS and 45 degrees of bank. The rejoin discussions in **paragraph 6.20.2** and **paragraph 6.20.3** apply to rejoins from all formation positions, including the terminal phases of tactical rejoins. (The initial phase of tactical rejoins is discussed in **Section 6C**.)

6.20.2. Straight-Ahead Rejoin:

6.20.2.1. Straight-ahead rejoins can be accomplished from a variety of situations, including pitchouts, take spacing, and instrument trail. The visual signal is a wing rock. A standard straight-ahead rejoin is to the left wing for Number 2 and the right wing for Numbers 3 and 4 (except for a rejoin from tactical where the wingman joins to the side he or she is currently on). The standard, straight-ahead rejoin airspeed is 300 KIAS.

6.20.2.2. During the rejoin, wingmen should fly to a position slightly below and behind lead, avoiding lead's jetwash. Using power for closure (50 knots of overtake is usually adequate when starting from 1 nm), the wingman will maintain this aspect to approximately 1,500 to 2,000 feet behind lead. (**Note:** Approximately 1,500 feet behind lead, the figure-eight design of the two tailpipes is visible, but two separate engines are not distinguishable.) At this point behind lead, the wingman will begin decreasing the overtake and make a slight bid to rejoin approximately two to four ship widths from lead, ensuring the overtake is controlled before closing from route to fingertip.

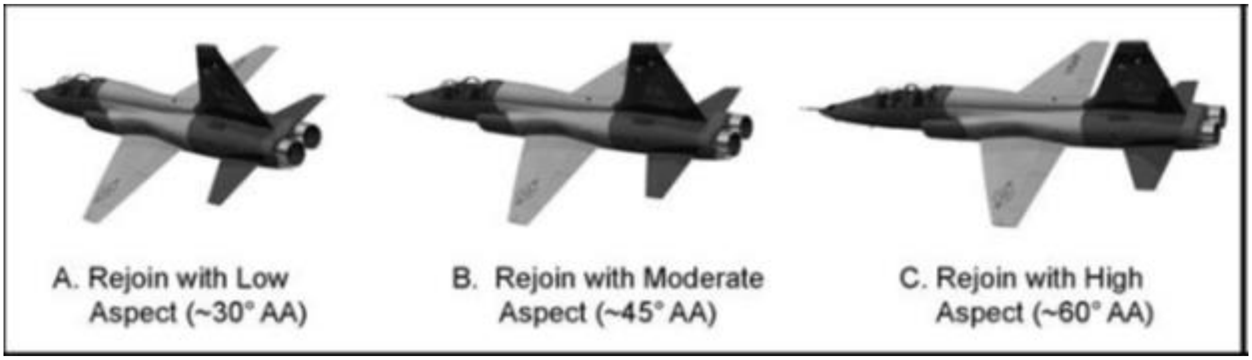
6.20.3. Turning Rejoins:

6.20.3.1. Rejoins to Number 2 (Inside the Turn):

6.20.3.1.1. The visual signal for a turning rejoin is also a wing rock, with the first wing dip in the direction of the rejoin. The standard turning rejoin to Number 2 is done at 300 KIAS and 30 degrees of bank. Because turning rejoins can be accomplished from many different positions, wingmen must initially assess the combinations of range, aspect, and energy state to establish appropriate aspect angles, pursuit curves, and overtake airspeeds.

6.20.3.1.2. After the signal and lead's turn, the wingman begins a turn in the same direction to create lead pursuit. Simultaneously establish vertical separation, establish approximately 30 knots of overtake, and adjust lead and lag pursuit to maintain moderate aspect angle (**Figure 6.8**)

Figure 6.8. Various Aspect Views.



6.20.3.1.3. Use IAS and visual cues to judge closure on lead. Control closure by adjusting the pursuit curve and the power. Use the speed brakes as needed, but plan the rejoin so that speed brakes are not required to complete the rejoin. Complete the rejoin to fingertip similar to reforming from the route position.

6.20.3.1.4. During a turning rejoin, wingmen should establish and maintain about 50 feet of vertical separation below lead's POM until stabilized in route formation. Other airspeed aspect combinations may be used if needed to complete the rejoins. Regardless of rejoin combinations, airspeeds should be less than 50 knots overtake for low aspect rejoins, 30 knots for medium aspect rejoins, and 10 knots for high aspect rejoins when wingman are within 3,000 feet of lead. Avoid the tendency to reduce closure by increasing G inside the turn.

6.20.3.2. Rejoins to Number 3 or 4 (Outside the Turn). For three- or four-ship formations, aircraft will rejoin in the proper numerical sequence. Number 2 will rejoin to the inside of the turn, and Numbers 3 and 4 will rejoin to the outside. When lead uses a visual signal to initiate the rejoin, each wingman will repeat the signal for aircraft in trail and maintain a minimum of 500 feet spacing from the preceding aircraft until that aircraft has stabilized in route. Rejoining aircraft will cross below the preceding aircraft's jetwash with a minimum of nose-tail clearance. Each aircrew will monitor the preceding aircraft's rejoin for excessive closure and anticipate overshoot and breakout situations from preceding aircraft.

6.21. Overshoots:

6.21.1. Overview. The purpose of an overshoot is to safely dissipate excessive overtake and/or decrease excessive angle-off during a rejoin. Wingmen must not delay the overshoot in an unusually aggressive attempt to "save" a rejoin. Keep lead and the preceding aircraft in sight at all times during any overshoot.

6.21.2. Straight-Ahead Rejoin Overshoot. A properly executed straight-ahead rejoin with excessive closure will result in a pure airspeed overshoot several ship widths out, with a slight diverging vector. Select idle and speed brakes (if required) as soon as excess overtake is recognized. Guard against turning back into lead while looking over your shoulder. A small, controllable 3/9 line overshoot is easily managed and can still result in an efficient rejoin. Retract the speed brakes and increase power just prior to achieving co-airspeed (stagnant LOS) to prevent falling aft.

6.21.3. Turning Rejoin Overshoot:

6.21.3.1. A properly executed turning rejoin with excessive VC will result in a combination airspeed-aspect overshoot in a POM about 50 feet below lead. The decision to overshoot should be made early so the wingman crosses lead's low 6 o'clock with a minimum of approximately two ship lengths of spacing. In all cases, ensure nose-tail separation can be maintained. Select idle and speed brakes as required, depending on excess airspeed.

6.21.3.2. Once outside the turn, use bank and back stick pressure as necessary to stabilize in route echelon position. During the overshoot, fly no higher than route echelon. The more airspeed and/or angle-off, the more turn radius required to solve the problem. In addition, a co-speed overshoot due to an angular problem only may not require flying outside of lead's turn circle. Instead, flying to lead's low six o'clock may allow enough forward visibility to safely align fuselages and stop the overshoot. When range, LOS, and angle-off are under control, return to the inside of lead's turn, reestablish an appropriate aspect angle, and complete the rejoin to fingertip.

6.21.4. Three- and Four-Ship Overshoot Deconfliction. As with a rejoin, maintain a minimum of 500 feet spacing from the preceding aircraft until it has completed the overshoot and is stabilized. If overshooting, preceding aircraft will inform the other wingmen with a radio call.

6.22. Breakout:

6.22.1. When in close proximity to another aircraft, break out when:

6.22.1.1. **(1)** directed by lead

6.22.1.2. **(2)** unable to maintain sight of lead

6.22.1.3. **(3)** unable to rejoin or remain in formation without crossing under or in front of lead

6.22.1.4. Or (4) any time your presence constitutes a hazard to the formation.

6.22.2. For breakouts, predictability is critical for all players. Lead should continue the current maneuver with the current power setting if possible. However, if the wingman is in sight, maneuvering to obtain, increase, or guarantee separation may also be appropriate or necessary. In all cases, lead should try to stay visual and be directive with the wingman as appropriate (“roll out,” “come left,” “visual at your right 2 o’clock high,” “cleared to rejoin—left turning,” etc.).

6.22.3. Wingmen should clear in the direction of the breakout, maneuver to ensure safe separation from other aircraft, and notify lead, if required, when conditions permit. Once safe separation is assured, the wingman may roll out to attempt to regain the visual. After the wingman calls visual, lead will direct him or her to the desired formation.

6.22.4. Control inputs can vary anywhere from a maximum rate stick deflection to avoid a collision to a small check-turn away. If breaking out due to a lost-sight situation, the wingman will break away from lead’s last known position or direction of turn, using power and/or speed brakes as required.

6.22.5. A breakout exercise may be accomplished from a variety of positions and situations. Lead will direct the breakout with a radio call, after which the wingman will simultaneously execute an appropriate breakout maneuver and make a radio call (“Pistol 2’s breaking out”). The culmination of the exercise is the same as described in **paragraph 6.22.3**.

6.23. Close Trail:

6.23.1. Lead initiates close trail with a radio call from fingertip, echelon, or route. He or she will wait for the wingman to call “in” before maneuvering and then use any combination of turns, modified lazy eights, or barrel rolls.

6.23.2. Over-the-top maneuvering in close trail is not permitted. Be smooth and predictable, avoid rapid or inconsistent turn rates, and maintain positive G forces at all times. Use no more than 4 Gs for close trail.

6.23.3. The wingman will acknowledge the call to go close trail (“2”), maneuver to the close trail position, and call in (“Gundog 2’s in”). Proper position is one to two aircraft lengths behind lead and just below lead’s jetwash.

6.23.4. In the correct vertical position, you should see space between the forward edge of lead’s horizontal tail and the trailing edge of lead’s wing. To prevent encountering jetwash, never fly higher than a position where that space disappears.

6.23.5. For a fore-aft separation reference, use the relationship between the tips of lead’s horizontal tail and the ailerons. At approximately one ship length, the elevator tips are lined up with the outer two-thirds of the ailerons. At approximately two ship lengths, the tips are lined up with the midpoint of the ailerons. When you are out of position too far back or when lead is turning at higher G-loadings, you may need to fly slightly inside the turn to gain or maintain position.

6.23.6. Terminate the exercise by directing wing to the desired formation using visual signal or radio call. If returning to fingertip, lead must avoid any significant power changes until wing is in position.

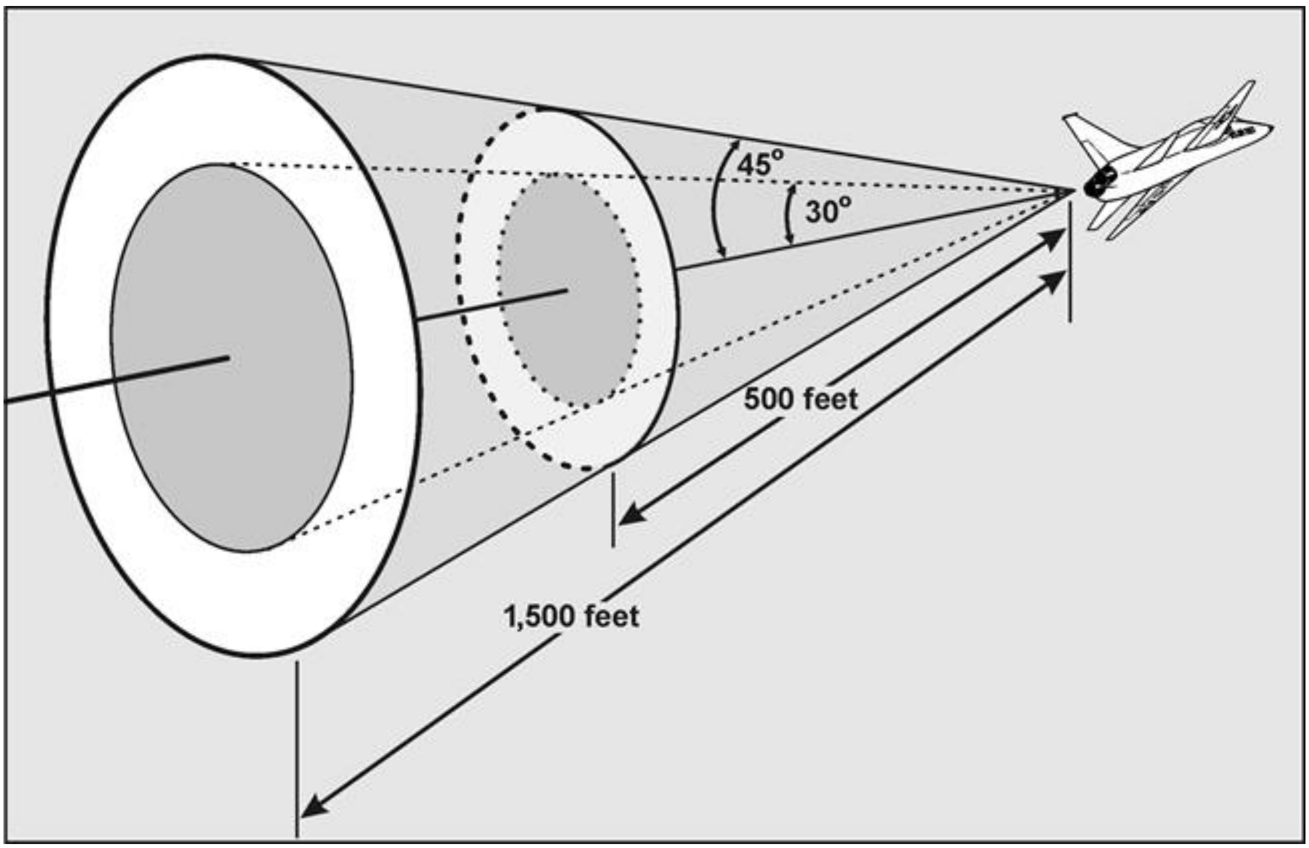
6.24. Fighting Wing. Fighting wing is flown as a maneuverable administrative formation. Lead directs Number 2 to the fighting wing position with a radio call or prebriefed visual signal, and Number 2 acknowledges the radio call (“2”). There is no requirement to call in position. The fighting wing position is a cone 30to 45-degree aspect angle from lead, 500 to 1,500 feet aft (**Figure 6.9**) The wingman modulates power as required to maintain his or her position. Do not fly aerobatic maneuvers in fighting wing.

6.24.1. As wing, you can approximate the forward limit of the cone (45-degree AA) by aligning lead's wingtip with the middle of the aft canopy and the aft limit (30-degree AA) by aligning lead's wingtip with the nose of the aircraft.

6.24.2. Another technique to estimate AA is to compare the apparent wingspan to the apparent length of the T-38. At 30-degrees AA, the apparent length equals the apparent wingspan. At 45- degrees AA, the apparent length is approximately 30 percent longer than the apparent wingspan.

6.24.3. For estimating range, at 500 feet you should easily read lead's tail number; at 1,000 feet, you should easily see, but not be able to read, lead's tail number; and you should be able to discern two separate tail pipes. The wingman should strive to maintain a position inside lead's turn circle using lead and lag, resulting in lower power settings.

Figure 6.9. Fighting Wing Cone.



6.25. Extended Trail (ET):

6.25.1. The primary emphasis of an extended trail exercise is on the use of pursuit curves and dynamic maneuvering to maintain the fighting wing position. Both aircraft initially use the same power setting, but the wingman may adjust the power if a power differential becomes apparent.

6.25.1.1. The ET Cone. The cone for ET is defined as 30°- 45° AA on lead and between 1,000 to 3,000 feet range. Wing evaluates position in the ET cone using visual references and stadiametric range estimation.

6.25.1.2. Visual References. For wing, the reference for the 30° and 45° AA is the same as for the fighting wing position. For visual ranging:

6.25.1.2.1. At 1,000 feet, you should easily see, but not be able to read, lead's tail number, and you should be able to discern two separate tailpipes.

6.25.1.2.2. At 3,000 feet, you can just start to make out detail on the airplane. You should be able to recognize detail such as a clearly visible canopy and canopy bows, shoulders (intakes), distinct lines where the wings and tail meet the fuselage, a distinct horizontal stabilizer, and clear lines where the colors on the paint scheme change.

6.25.1.2.3. At 4,000 feet, just outside the ET cone, is where the VHF antenna ("shark fin") disappears; however, this reference requires the belly of lead's aircraft to be in view.

6.25.2. Extended trail is entered from any formation position. However, if entered from tactical or spread, lead will maintain a rejoin platform until the wingman calls "in." Lead will initiate the extended trail exercise with a radio call ("Colt 21 go extended trail"), and the wingman will acknowledge ("2"). Lead will maneuver by pulling away from the wingman with a moderate G turn. The wingman will maneuver aft and away from lead to attain the extended trail position. Lead aircraft sets MIL power until the wingman calls in ("Colt 2's in").

6.25.3. Once the wingman calls in, both aircraft set 600 degrees EGT or a prebriefed power setting (550 degrees EGT to MIL if over-the-top maneuvering is planned), and the lead aircraft may begin aerobatic maneuvering as required.

6.25.4. Lead is not required to perform maneuvers to the precise parameters used in contact flying. Lead may vary the attitudes and airspeeds as necessary for effective training, area orientation, visual lookout, and smoothness. Lead will consider the wingman's skill level while maneuvering to prevent exceeding the wingman's capabilities, but will continue to challenge with hard turns, modified lazy-eights, barrel rolls, and over-the-top maneuvers. High-G maneuvers are of little value if the wingman is unable to maintain the proper position. Lead must remain constantly aware of G forces because the wingman is often exceeding lead's G level to maintain or regain position. Lead should attempt to keep the wingman in sight, but not sacrifice visual lookout to do so. However, lead should keep SA of the wingman's position at all times. Limit extended trail maneuvering to turns, lazy eights, barrel rolls, cloverleafs, loops, and Cuban eights.

6.25.5. Lead will not attempt to maneuver to force a wingman overshoot. The wingman should strive to maintain a position from which lead can stay visual. The only time a wingman should be directly aft of lead is when crossing from one side to the other. Do not perform abrupt turn reversals; that is, turns in one direction followed by a rapid, unanticipated roll into a turn in the opposite direction.

6.25.6. Lead will terminate the extended trail exercise by directing a rejoin or sending the wingman to any another formation position (except close trail). Lead will initiate the rejoin with a radio call or a wing rock, and if rejoining, will not adjust the power until the wingman has acknowledged the call or is in sight. The extended trail exercise is flown two-ship only.

6.25.7. The wingman rarely remains in a static position during an extended trail exercise. When crossing from one side to the other, the wingman should plan to cross above or below lead's jetwash. The wingman should unload the aircraft to prevent an asymmetric over-G if he or she goes through the jetwash. Any time the wingman wants lead to discontinue maneuvering (because of loss of spacing, etc.) he or she will notify lead with a "terminate" call. Lead will smoothly transition to a turn and direct the wingman to either resume the exercise or rejoin.

6.25.8. As a wingman, energy conservation is very important. High AOA buffet in a high-performance aircraft signifies a loss of energy. When encountering buffet, you must decide what is more important, nose track or airspeed. If nose track is more important, you may have to sacrifice airspeed by pulling in the buffet. Realize that sacrificing airspeed for nose track may eventually result in excessive spacing anyway. Unloading the aircraft may increase airspeed, but if lead is in a hard turn, this can result in excessive spacing, excessive angle-off, or both.

6.25.9. As with other formation maneuvering, each pilot has the responsibility to take whatever action is necessary to avoid a collision. Because of the dynamic nature of an extended trail exercise, the problems of collision avoidance are compounded and require uncompromising flight discipline. Either aircraft should use the "knock-it-off" radio call to cease maneuvering when any of the extended trail parameters or training rules have been violated by either aircraft. Aircraft flying inside the 500-foot minimum slant range or forward of the 3/9 line will call "knock-it-off" as described in **paragraph 6.9**.

6.25.10. When one or more flight members lose visual contact, follow the loss of visual contact procedures in AFMAN 11-2T-38, Volume 3. Refer to **paragraph 6.64.6** of this manual for an expanded discussion of lost sight.

Section 6C—Tactical Formations

6.26. Types and Principles:

6.26.1. "Tactical" is an umbrella term covering several formations characterized by increased separation between the members of the flight. Tactical is the primary formation flown when employing fighter aircraft. It is designed to optimize weapons and radar employment while improving visual lookout and increasing maneuverability.

6.26.2. A variety of tactical formations may be flown, depending on the number of aircraft in the formation and the type of employment desired. For two-ships, the formations include line abreast and wedge. Line abreast is the most basic tactical formation and is most commonly referred to as "tactical." For four-ships, tactical formations include fluid four, wall, and box or offset box. Regardless of the variety of tactical formation being flown, some basic principles apply:

6.26.2.1. The lead aircraft is primarily responsible for maneuvering the formation, and the wingman is primarily responsible for maintaining formation position and deconfliction.

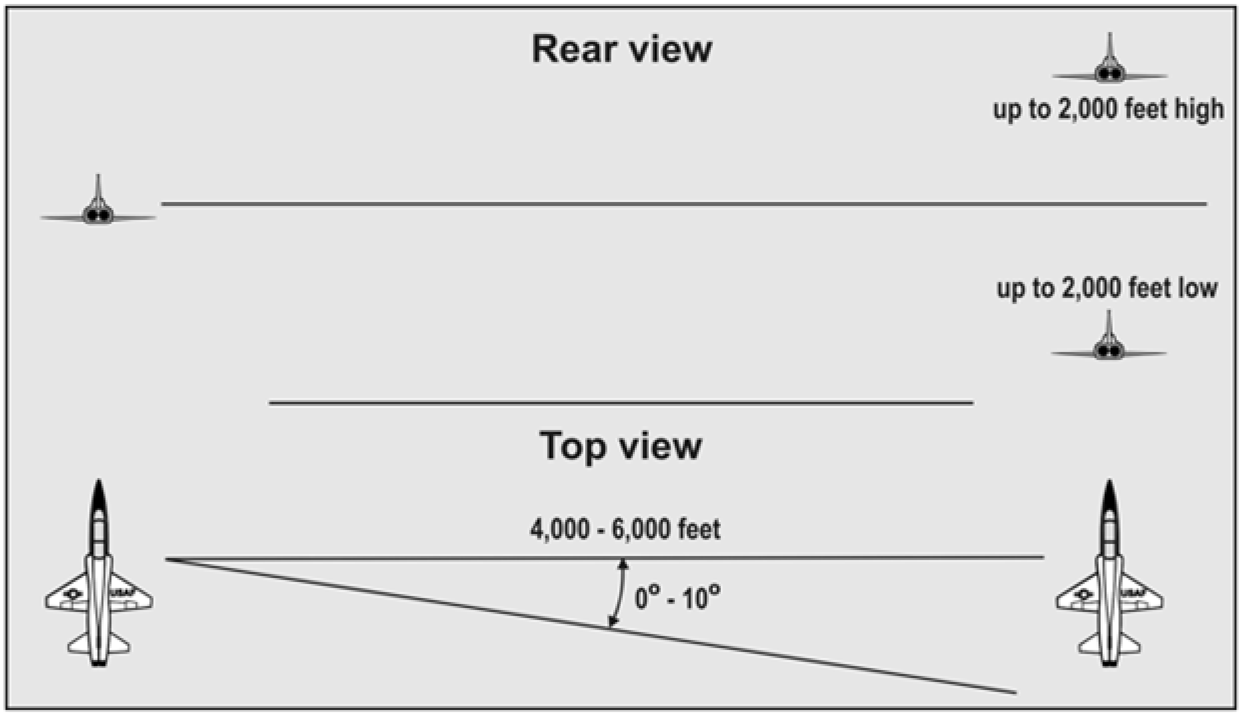
6.26.2.2. The wingman's primary reference for heading and airspeed is lead. The lead must cross-check the wingmen to monitor their position, and the wingmen must back lead up by monitoring area orientation, navigation, etc.

6.26.2.3. Both aircraft share equal responsibility with visual lookout—one of the primary reasons for flying tactical line abreast. Line abreast provides excellent lookout capability. Scan patterns should include the extremes above and below the horizon.

6.26.2.4. Tactical formations are normally flown at airspeeds near corner velocity (350 to 400 KIAS), but other airspeeds may be flown. Unless otherwise briefed, the standard airspeed for tactical formation is 350 KIAS at or above 10,000 feet MSL and 300 KIAS below 10,000 feet MSL.

6.27. Line Abreast (Tactical). The parameters of tactical formation are defined as 4,000 to 6,000 feet, line abreast to 10 degrees aft, with a vertical stack of up to 2,000 feet (**Figure 6.10**). Maintain standard formation within 100’ vertically of lead while outside special use airspace.

Figure 6.10. Tactical Line Abreast.



6.27.1. To enter tactical formation, lead may use a radio call (“Phantom 21, go tactical”) or a visual signal by porpoising the aircraft. The wingman then moves out into the tactical position, clearing the flightpath while moving out. In order, the priorities for correcting formation position are fore and aft positioning, lateral separation, and vertical stack. Strive to fly line abreast—no further aft than 10 degrees—by varying power and trading altitude for airspeed (or vice versa) to make fore or aft corrections.

6.27.2. Lateral separation is best managed by making accurate assessments of lateral spacing and heading corrections consistent with the amount of correction needed. Visual references for lateral spacing are as follows: at 4,000 feet, the canopy bow disappears and both canopies blend into one; at 6,000 feet, the canopies blend in with the aircraft; and outside 6,000 feet, most details—like the burner can—disappear and the aircraft loses most of its shape “definition.” Air-to-air TACAN can be used to help calibrate your eyes to the correct lateral separation.

6.27.3. Strive for a minimum vertical stack of 1,000 feet, but do not hesitate to increase the size of the stack. Some situations may warrant a stack in excess of 2,000 feet, such as using altitude to correct fore or aft positioning. When restricted by airspace or weather, you may be required to fly co-altitude with lead.

6.27.4. Accomplish small course corrections through check turns. Accomplish turns of more than 30 degrees by means of a delayed turn (45 degrees through 90 degrees), in-place turn, or fluid turn. For reversing the flightpath 180 degrees, use a hook turn or cross turn.

6.28. Tactical Turns. The following basic concepts apply to all tactical turns (except fluid turns):

6.28.1. Radio calls or visual signals may be used to signal tactical turns. For example, the radio call for a delayed 90-degree turn would be "Knight 11, 90 left/right." No radio response is required from the wingmen. All tactical turns except a cross turn or hook turn into the wingman may be signaled with a wing flash in the direction of the turn. Lead should show the wingman the full planform (approximately 90 degrees bank) when signaling a tactical turn to avoid confusion with minor course corrections (usually 30 degrees of bank or less). If needed to attract the wingman's attention, a "zipper" may be combined with the visual signal. Wingmen always assume the turn is a delayed 90-degree turn until signaled otherwise.

6.28.2. As the turns are executed, all aircraft need to adhere to a "contract" during the turn to ensure turn radius are similar. Use the following parameters for contract turns: constant airspeed, MIL power, and 4 Gs or light tickle (whichever occurs first). Plan to fly level turns, but wingmen may vary altitude and Gs as necessary to maintain formation position. At medium or high altitudes, some aircraft may have to sacrifice altitude to maintain proper airspeed or position. At lower altitudes, all aircraft must remain aware of terrain elevation, descent rate, and bank angle.

6.28.3. The wingman takes the initiative to deconflict from lead. Typically, the wingman will ensure separation by turning above lead's flightpath whenever possible (the concept of "Number 2 always goes high"). When unable due to position (for example, stacked low), environment, or other reasons, the wingman should telegraph his or her intentions to lead by positively maneuvering the jet. Both lead and wingman are ultimately responsible for flightpath deconfliction and must clear during the turns and take appropriate evasive action as required.

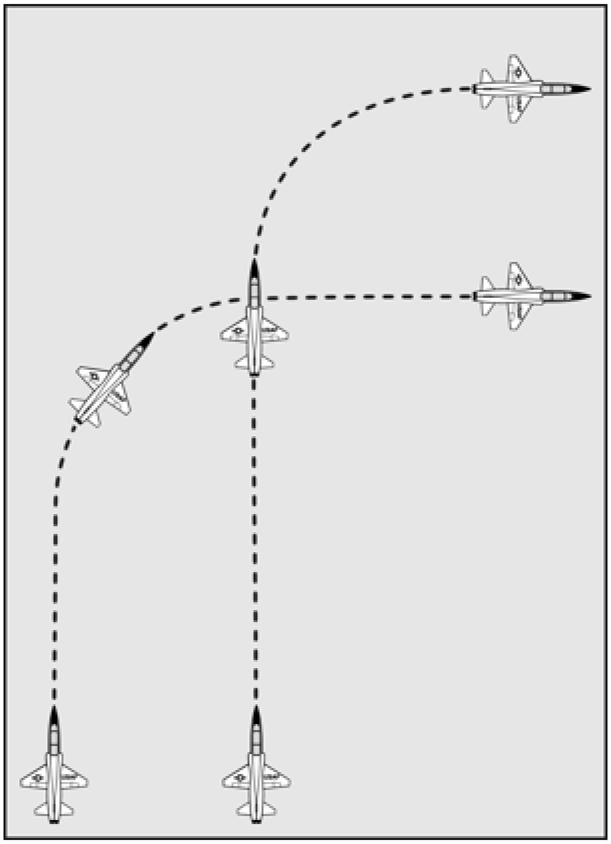
6.29. Delayed 90-Degree Turns:

6.29.1. A 90-Degree Turn Into the Wingman:

6.29.1.1. If the turn is called over the radio, lead begins the contract turn immediately after the call. Otherwise, lead's contract turn into the wingman signals the turn. As lead begins the turn, the wingman continues straight ahead and deconflicts the turn by obtaining vertical clearance. He or she should use this opportunity to clear lead's new 6 o'clock position. The wingman will initiate a 90-degree contract turn to roll out in tactical on the other side of lead.

6.29.1.2. The timing for starting this turn normally occurs just prior to observing a rapid increase in lead's LOS (**Figure 6.11**.) If the wingman is in position, the increase in LOS will occur after lead has turned approximately 45 degrees (just prior to looking down lead's intakes). If out of position, the wingman will vary the timing and G-loading of the turn, based on lead's LOS, to finish the turn in position. Generally, when the wingman is too close or too far aft, he or she should begin the turn earlier. When the wingman is too wide or too far forward, he or she should begin the turn later. Also, when in proper position at lower altitudes, the wingman should begin the turn later due to a smaller turn radius. (The opposite is true at higher altitudes.)

Figure 6.11. Delayed 90-Degree Turn.

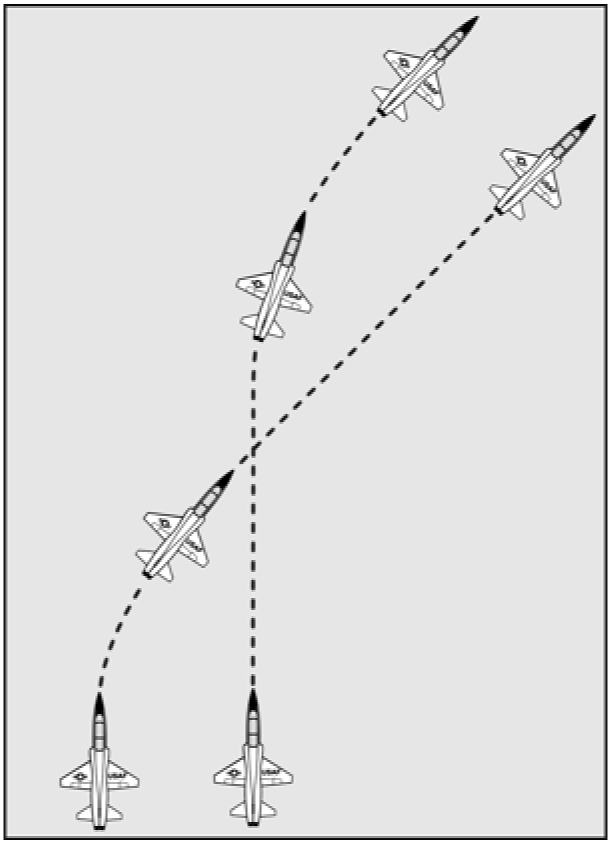


6.29.2. A 90-Degree Turn Away From the Wingman. This is a mirror image of the 90-degree turn into the wingman. When directed, the wingman begins a contract turn into lead and uses all available references to roll out after approximately 90 degrees of turn. Lead delays and then performs a contract turn to roll out on the desired heading. During lead's turn and rollout, the wingman maneuvers to the correct position.

6.30. Delayed 45-Degree Turns:

6.30.1. A 45-Degree Turn Into the Wingman (**Figure 6.12**) If the turn is called over the radio, lead begins the turn immediately after the call. Otherwise, lead's turn into the wingman signals the turn. As lead begins the turn, the wingman continues straight ahead and deconflicts by obtaining vertical clearance. The wingman should use this opportunity to clear lead's new 6 o'clock position. When lead rolls out, the wingman maneuvers as required to achieve a tactical position on the other side of lead's aircraft by either delaying the turn until lead crosses the 6 o'clock position or by immediately maneuvering to the other side of lead. During comm-out turns, lead must ensure the rollout occurs before the wingman begins a delayed 90-degree turn. If the wingman begins a 90-degree turn, lead should use the radio to achieve the desired turn.

Figure 6.12. Delayed 45-Degree Turn.



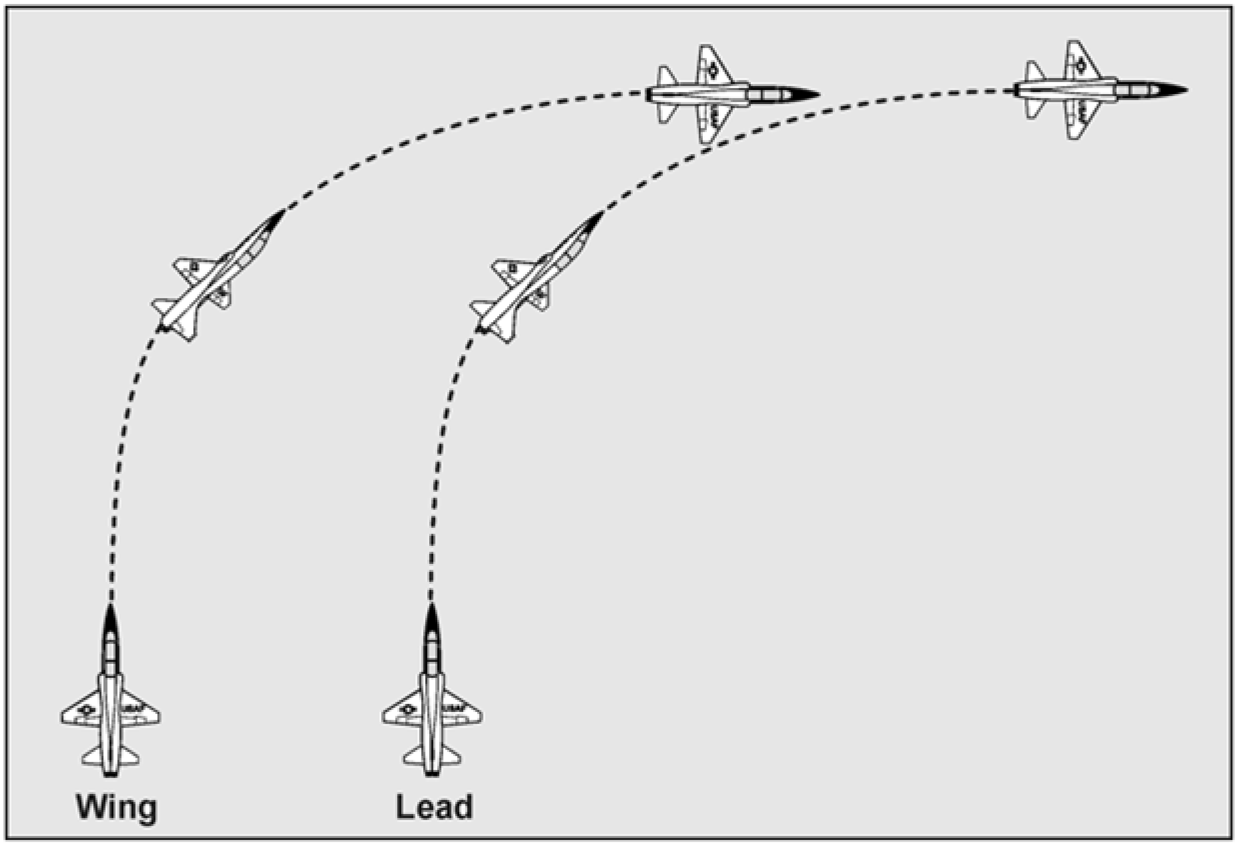
6.30.2. A 45-Degree Turn Away From the Wingman. This is a mirror image of the 45-degree turn into the wingman. When directed, the wingman begins a contract turn into lead. Lead signals the wingman's rollout by beginning a contract turn into the wingman. Lead will maneuver to the opposite side of the wingman in a line abreast position. After lead rolls out, the wingman's responsibility is to obtain the correct spacing and position.

6.31. Other Tactical Turn Variations. For turns greater than approximately 60 degrees, lead will generally direct a delayed 90-degree turn. For turns between approximately 30 to 60 degrees, lead will generally direct a delayed 45-degree turn. For turns approximately 30 degrees or less, lead will call a check turn and turn to the desired heading. In all cases, the wingman's responsibility is to maintain or regain position.

6.31.1. Check Turn. The check turn is usually no more than 30 degrees of turn. Initiate the turn by transmitting, "Frisco 31, check (degrees to turn) left/right." Both aircraft turn simultaneously, using a contract turn; and the wingman remains on the side he or she is currently on.

6.31.2. In-Place Turn. Use an in-place (**Figure 6.13**) turn when you want the formation to maneuver in one direction at the same time. To initiate, lead transmits "Smurf 11, in-place 90 left/right." Both aircraft turn at the same time—in the same direction—using contract turns. If executed from line abreast tactical, a 90-degree turn will put the formation in trail at whatever lateral spacing existed prior to the turn.

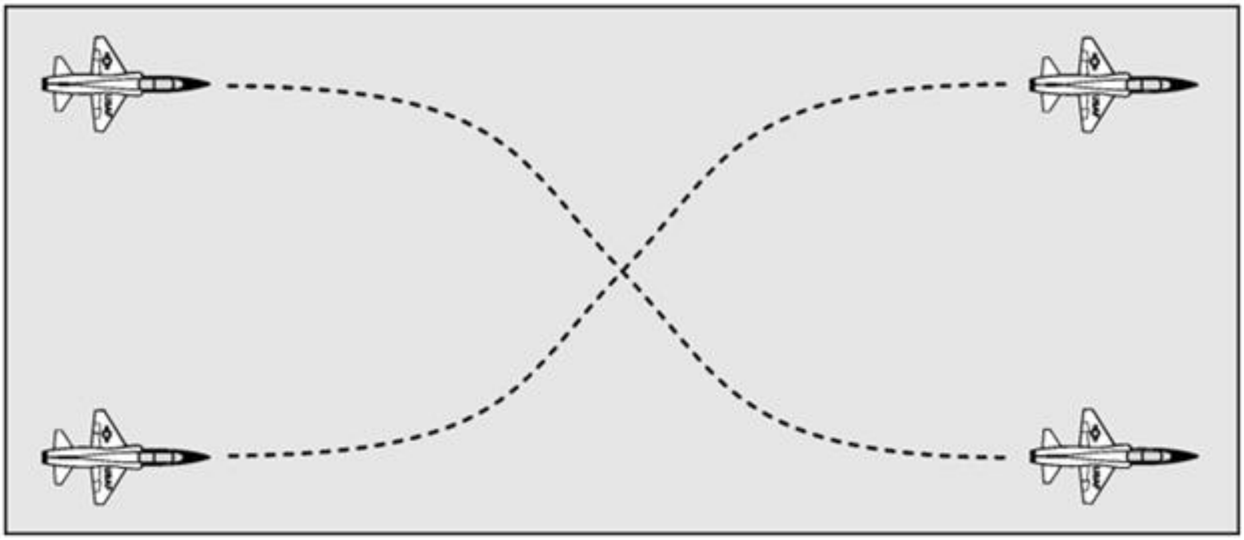
Figure 6.13. In-Place 90-Degree Turn.



6.32. Shackle:

6.32.1. Use a shackle (**Figure 6.14**) to put the wingman on the opposite side or to allow him or her to regain the correct position. Initiate the shackle by transmitting, "Snake 21, shackle." Both aircraft turn toward each other, with the wingman ensuring vertical deconfliction. Generally, Number 2 rolls out with lead to minimize fore-aft LOS. Both aircraft reverse the turn after crossing flightpaths. Lead rolls out on the original or desired heading, and Number 2 assumes proper tactical position.

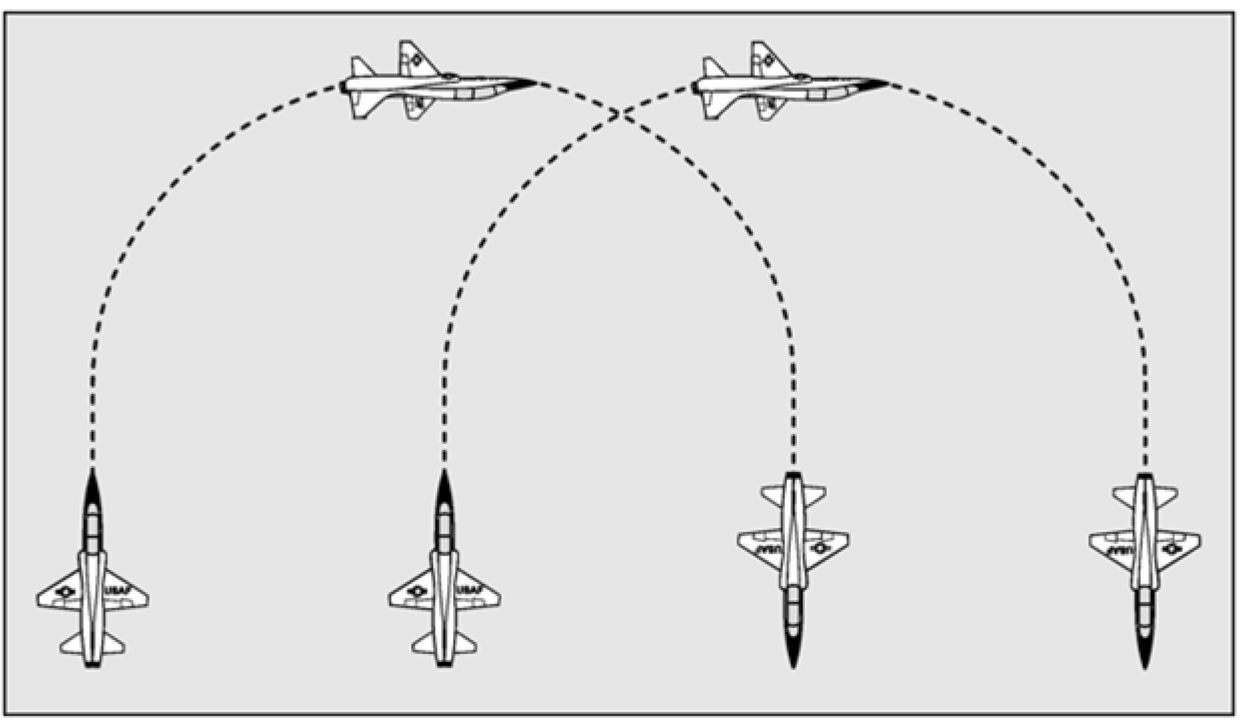
Figure 6.14. Shackle.



6.32.2. Not starting out line abreast, aircraft will maneuver during the shackle as appropriate for the situation. If the shackle is to allow the wingman to correct a forward position, the correct lead maneuver may be to continue straight ahead. If the wingman is ahead at the start of a shackle, he may use more bank and angle-off to regain the proper position. If the wingman is behind at the start of a shackle, he or she may use less bank and angle-off to regain the proper position.

6.33. Hook Turns. During a hook turn (**Figure 6.15**), the formation turns 180 degrees with both aircraft performing a contract turn at the same time in the same direction.

Figure 6.15. Hook Turn.



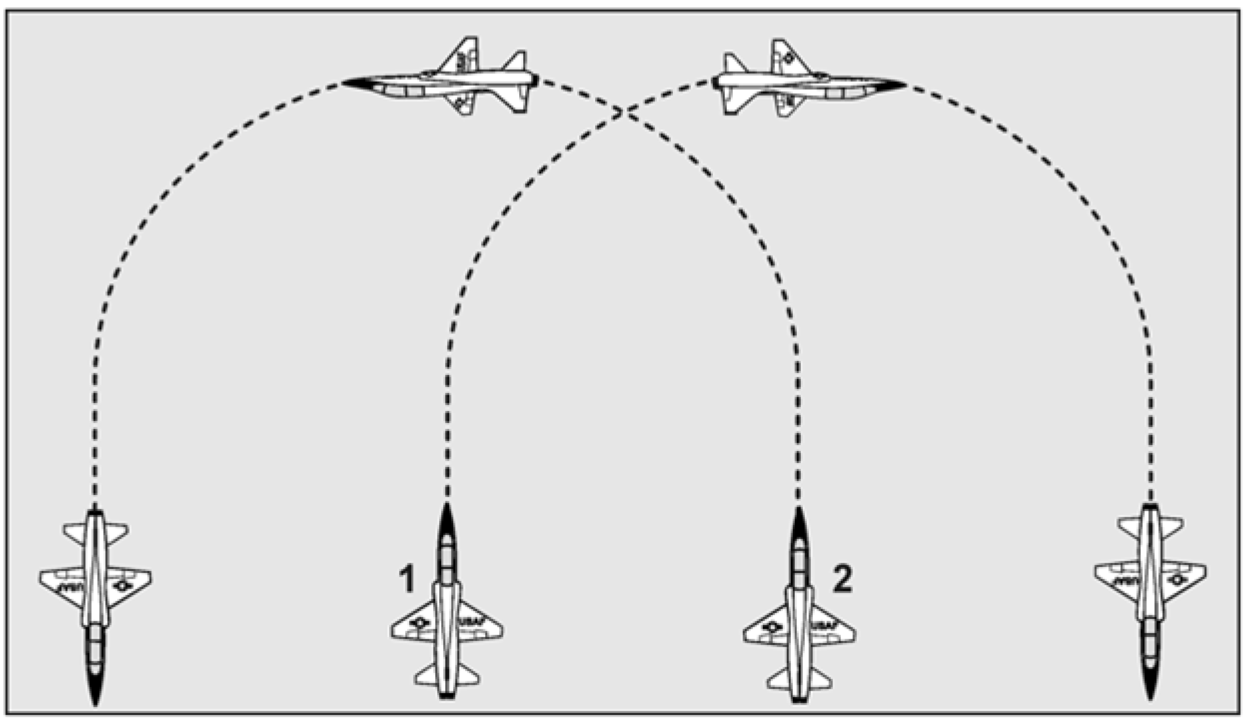
6.33.1. Hook Turns Into the Wingman. A hook turn into the wingman must be called over the radio ("Snake 01, Hook right/left"). During the first half of the turn, lead is responsible for keeping the wingman in sight. Shortly after halfway through the turn, the wingman should acquire, maintain sight of, and fly off of lead. If the turn is flown properly, the wingman will roll out in the correct position. If not, he or she must maneuver to obtain the proper spacing and position.

6.33.2. Hook Turns Away From the Wingman. Hook turns away from the wingman may be signaled visually by a wing flash or called over the radio. If initiated with a wing flash, lead will begin turning when the wingman begins the turn. Lead's immediate turn tells the wingman this is not a 90-degree turn. For the first half of the turn, the wingman should fly a contract turn while referencing the lead. He or she should match lead's fuselage through 90 degrees of turn to maintain position and use caution to avoid lead's jetwash. Shortly after halfway through the turn, lead should acquire and maintain sight of the wingman. If this turn is flown properly, the wingman will be in position at the rollout (exactly 180 degrees of turn). If not, he or she must maneuver to obtain the proper spacing and position.

6.34. Cross Turns:

6.34.1. Cross turns (**Figure 6.16**) are another 180-degree reversal option. Both aircraft make a contract turn into each other with altitude split for flightpath deconfliction. Two basic challenges occur during the turn: (1) reacquiring visual contact with the other aircraft, and (2) too much lateral spacing cause by the T-38's turn performance.

Figure 6.16. Cross Turn.

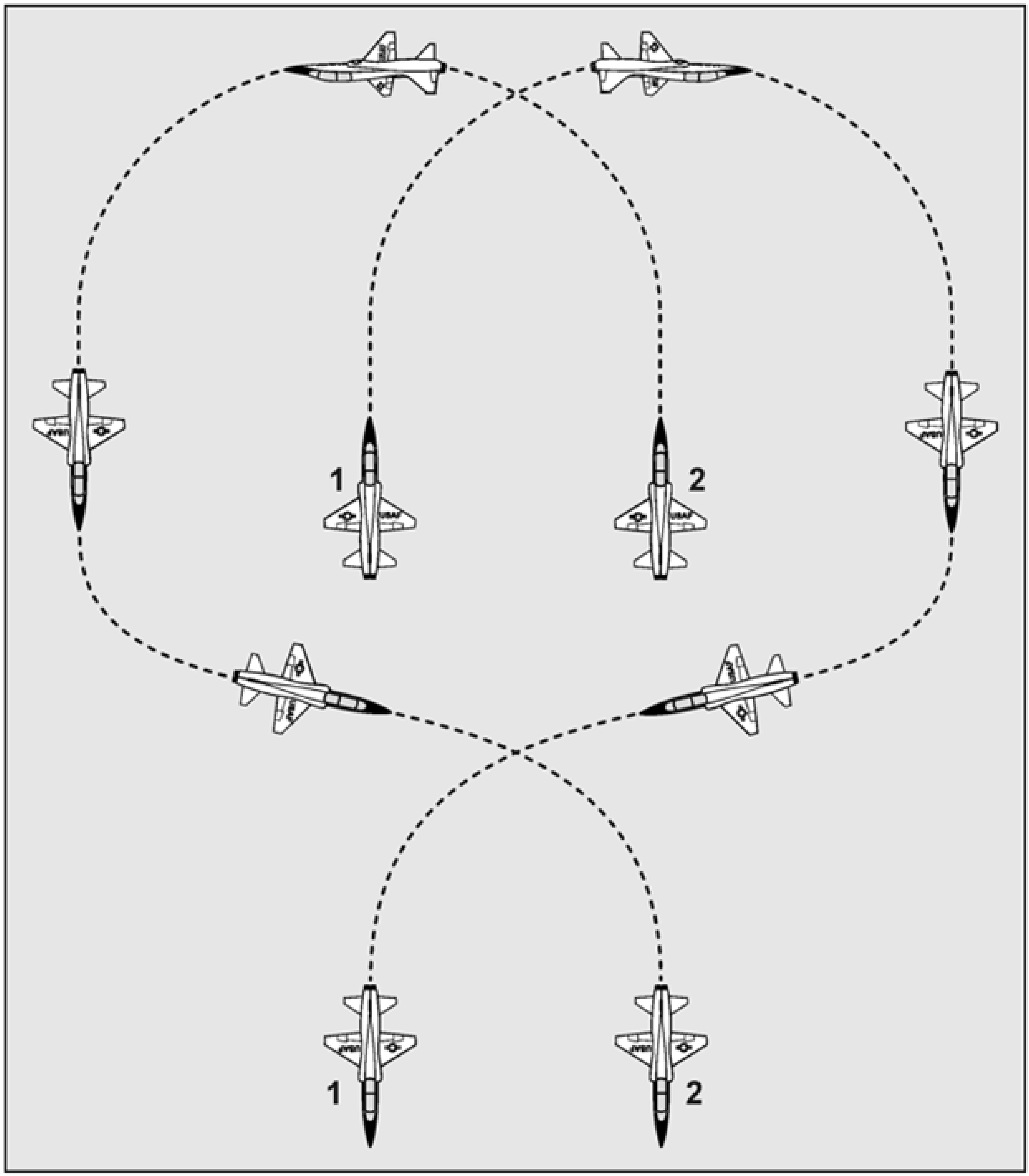


6.34.2. Cross turns will be executed on a verbal command from lead ("Cider 41, cross turn"). Immediately, both aircraft will commence a contract turn toward each other. Aircraft should cross after 60 to 90 degrees of turn and continue their turn through 180 degrees. The flight is now on a reciprocal heading; but, because of the large turn radius, the lateral separation will be wide (2 to 3 nm) if the original spacing was correct.

6.34.3. As quickly as possible after turning through 90 degrees, each pilot must reacquire and maintain visual with the other aircraft. If the other aircraft is not reacquired during the second half of the turn, call “blind” immediately upon rollout. Unless briefed otherwise, both aircraft maintain the rollout heading until lead directs a shackle.

6.34.4. To correct the spacing, generally perform a shackle after a cross turn (**Figure 6.17**) If the wingman is blind, but lead is visual, lead may direct a shackle while maintaining altitude separation and attempting to talk the wingman’s eyes back on lead. Due to the distance between aircraft, it is possible for neither pilot to regain sight after the cross turn. If this happens, both will maintain the reciprocal heading until directed otherwise by lead. Lead will ensure altitude separation.

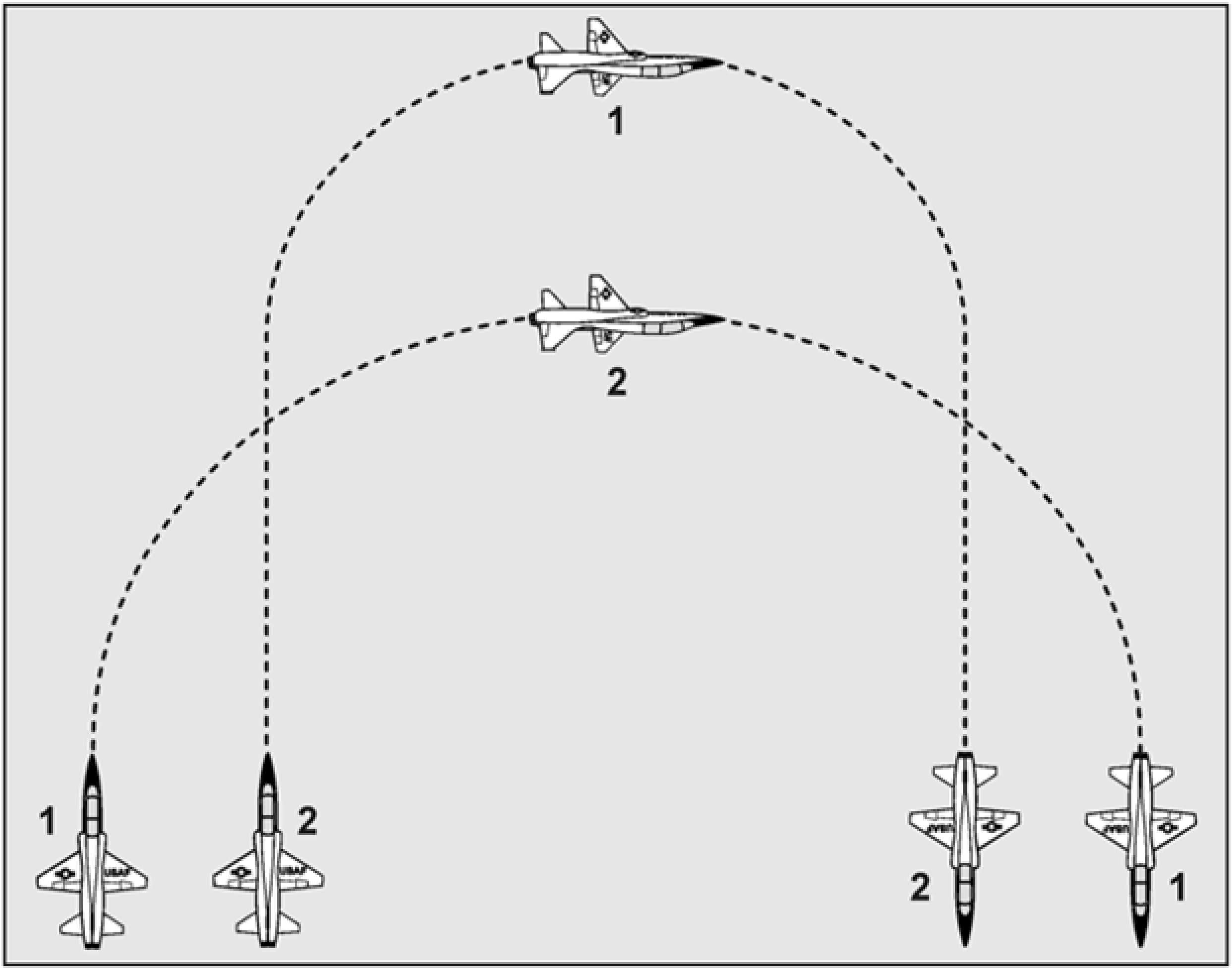
Figure 6.17. Cross Turn With Shackle.



6.35. Fluid Turns. These turns are used to maneuver a formation when there is very little G or excess thrust available (heavy weight and/or higher altitudes). Lead will normally make heading changes in 90-degree increments, using approximately 45 degrees of bank and maintaining airspeed and altitude. Also, fluid turns are almost purely "geometry" turns with power settings normally constant. If a 180-degree turn is required, combine the techniques for two 90-degree turns

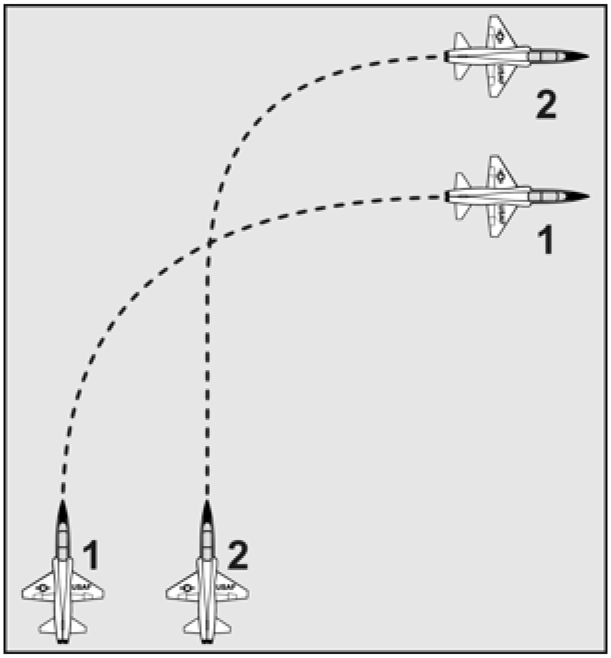
(**Figure 6.18**) The radio call for a fluid turn is “Snake 41, fluid left/right.” No acknowledgement is required.

Figure 6.18. Fluid Turn.



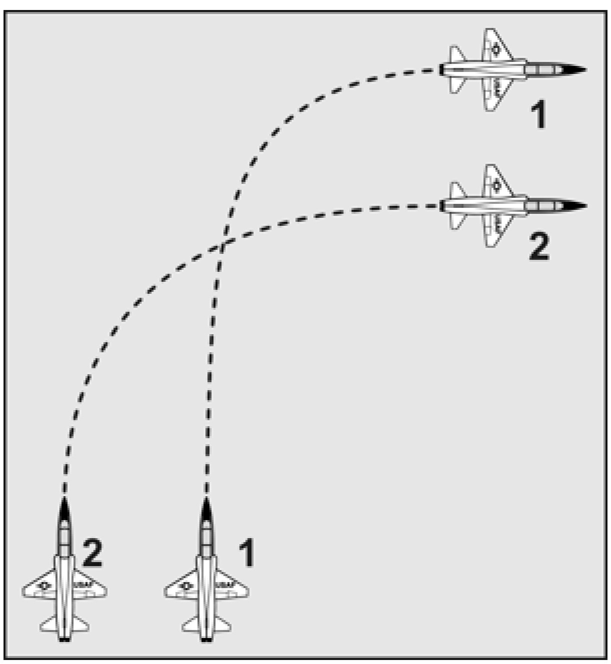
6.35.1. Turns Into the Wingman. As a wingman, start a turn in the same direction as lead (**Figure 6.19**) Whatever bank angle technique is used, you must continuously monitor lead’s position. You should normally have 20 to 30 degrees of turn completed as lead passes your 6 o’clock position, depending on lead’s position at the start of the turn. For example, if you were behind when the turn started, you may want to delay the cross. If you were ahead, you may want to cross earlier. Once you have crossed lead’s flightpath, adjust the turn to assume proper spacing and lower the nose to pick up airspeed, if necessary.

Figure 6.19. Fluid Turn Into the Wingman.



6.35.2. Turns Away From the Wingman. As depicted in **Figure 6.20**, the wingman is immediately behind at the onset of the turn. He or she will roll into more bank than lead and lower the nose slightly to gain airspeed in order to move to the inside of the turn behind lead. As the turn progresses, the wingman will reduce the bank to attain proper lateral spacing and trade excess airspeed for altitude as he or she approaches the line abreast position.

Figure 6.20. Fluid Turn Away From the Wingman.



6.36. High Altitude Tactical. When flying tactical formation above FL 250, the following techniques are useful:

6.36.1. Normally, 0.85 to 0.9 IMN is a good airspeed range because it provides both maneuverability and good fuel flow at the higher altitudes. These speeds also provide excess power and, except with extremely cold outside air temperatures, will maintain operations within the engine envelope.

6.36.2. Do not plan formation flights above FL 350. However, if you must operate above FL 350, use 0.9 IMN or slightly higher as the base airspeed.

6.36.3. Energy conservation is a priority at the higher altitudes because less thrust is available. Additionally, throttle movements must be small to avoid compressor stalls. The basic maneuvering remains the same; but, due to the increased emphasis on energy conservation, buffet should be avoided as much as possible. To accomplish this and to compensate for the higher true airspeed, use earlier lead turns than at lower altitudes. For example, during a delayed 90-degree turn into, start the turn as the other aircraft turns through approximately 30 degree of turn (rather than 45 degrees). This should be apparent with the LOS concept discussed in **paragraph 6.29.1.2**.

6.37. Wedge. Lead might direct the wingman to wedge formation when terrain, tactics, etc., require an increased degree of flight maneuverability. The wedge position is primarily used in the low altitude environment. Turns do not need to be called. The wingman will maneuver as required to maintain position. Wedge is defined as a position 30 to 45 degrees off lead's 6 o'clock (or 45 to 60 degrees aft of lead's 3/9 line) at a range of 4,000 to 6,000 feet. The wingman' will not fly lower than lead in the low altitude environment. He or she will fly no higher than approximately 500 feet above lead unless required to fly higher due to obstacle clearance during turns.

6.38. Tactical Rejoins:

6.38.1. Overview. All rejoins will be initiated with a wing rock or radio call. Wingmen will acknowledge all radio calls to rejoin. The standard platform for lead is 350 KIAS, 45 degrees of bank, and level flight. Different parameters may be briefed or called on the radio. Proficient wingman will not require a radio call when different parameters are used. Wingmen should strive to maintain closure during the rejoin.

6.38.2. Straight-Ahead Tactical Rejoin. As the wingman, rejoin to the side occupied when given the radio call or visual signal. Unlike a normal straight-ahead rejoin from a trail position, a tactical straight-ahead rejoin begins from a lateral spread. The mechanics of flying this maneuver will vary based on your position when initiating the rejoin. If necessary, maneuver vertically or laterally to gain turning room. Decrease the aspect angle with lag pursuit by turning toward lead. Then eliminate the resulting angle-off by aligning fuselages. The goal is to arrive slightly aft of and slightly below lead. After stabilizing (but not stopping) in this position, continue to move forward toward route and then into fingertip or the position directed by lead. To prepare for four-ship procedures, always attempt to accomplish straight ahead rejoins from tactical without crossing lead's 6 o'clock position.

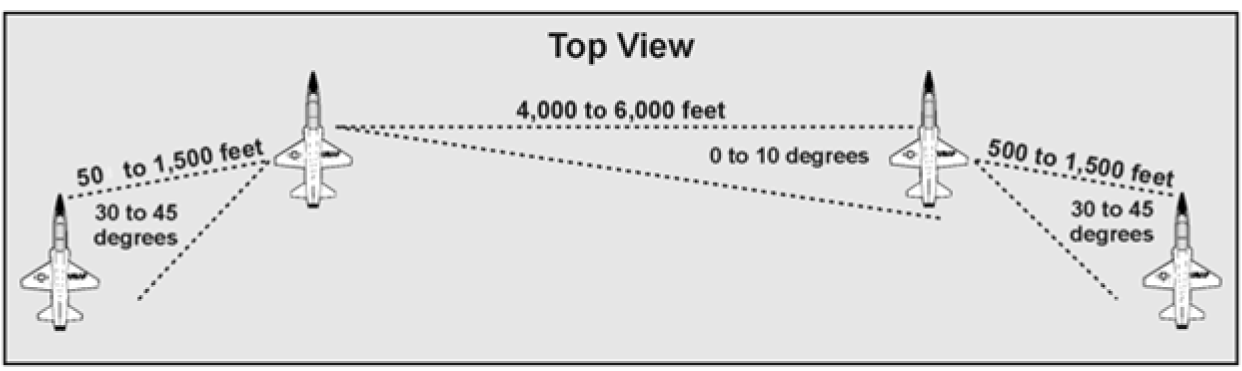
6.38.3. Turns Into the Wingman. Even before lead turns, you (the wingman) have excessive aspect angle and must use lag pursuit. Maneuvering to the outside of the turn solves this problem, but excessive lag pursuit will result in excessive angle-off when crossing outside lead's flightpath. If not properly handled, excessive angle-off will result in flying a much wider turn than lead. A turn in the vertical above or below lead will build maneuvering room to reduce the angle-off. By aligning fuselages as you approach lead's flightpath, angle-off will be reduced. Once the aircraft are aligned, make a bid to the rejoin line, crossing lead's 6 o'clock while remaining clear of his or her jetwash. On the inside of the turn, assess your overtake, establish the desired aspect angle, and then follow turning rejoin procedure to the Number 2 position or as briefed.

6.38.4. Turns Away From the Wingman. As soon as lead turns, you (the wingman) are outside the turn and need to maneuver to the inside of the turn with lead pursuit. Use caution because an excessive amount of lead pursuit may result in excessive aspect angle and/or closure. Cross lead's six o'clock while remaining clear of his or her jetwash and assess your overtake. Once inside lead's turn, use turning rejoin procedures to the Number 2 position or as briefed.

6.39. Four-Ship Tactical. A four-ship formation combines the basic elements of a two-ship tactical formation into a formation of four aircraft. The three four-ship tactical formations include fluid four, wall, and box or offset box. With the increased number of aircraft in the formation, all flight members must maintain visual awareness or SA on the other aircraft to ensure deconfliction. Strictly adhering to the contract turns and aggressively maintaining proper formation position will greatly reduce the risk of a formation midair collision. Although each pilot maintains an obligation to remain visual on all aircraft, there are situations that prevent this. The priority for wingmen is to maintain visual with, and maneuver in relation to, their element lead. Number 3's priority is to maintain visual with Number 1. Any time these priorities cannot be fulfilled, the flight must be informed with a timely "blind" call.

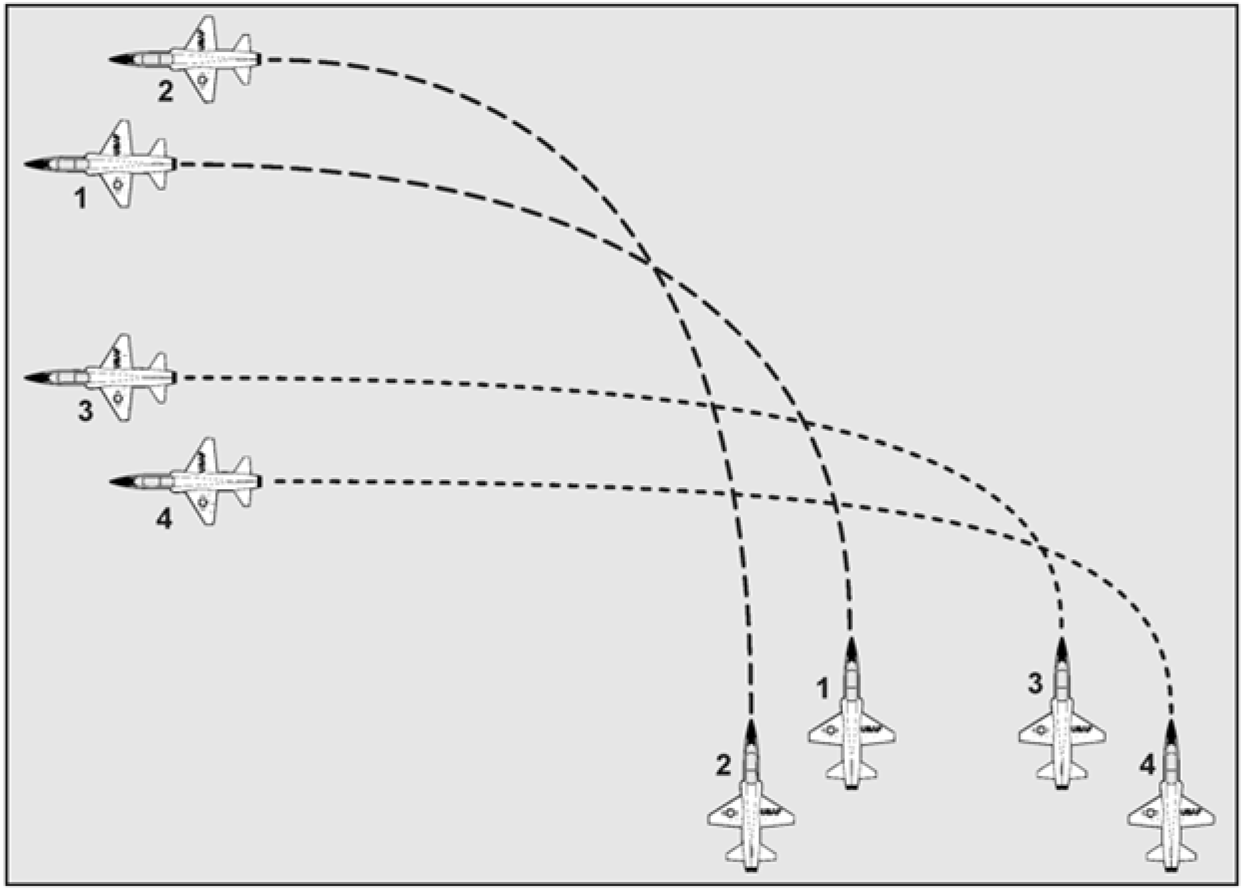
6.40. Fluid Four. Fluid four is a simple and efficient formation for medium and high altitudes (**Figure 6.21**)

Figure 6.21. Fluid Four Formation.



6.40.1. Element leads (Numbers 1 and 3) fly two-ship tactical line abreast. Numbers 2 and 4 fly a fighting wing position off their respective element lead, striving to maintain a position on the outside of the formation when not maneuvering. Tactical turns (**Figure 6.22**) are made between Number 1 and Number 3, the same as in a two-ship tactical. Element leads can make it easier for their respective wingmen to stay in position by pausing momentarily between banking up and beginning to pull during turns, allowing the wingmen to begin to maneuver for the turn.

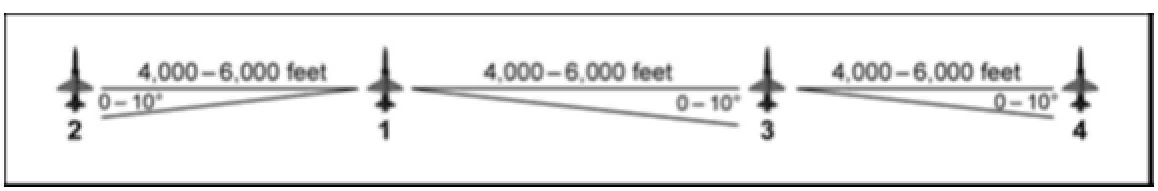
Figure 6.22. Fluid Four Turns.



6.40.2. The highest potential for conflict occurs during the turns as elements cross during the turn. If the element leads are line abreast at the start of the turn, this conflict is minimized, but still exists if the wingman in the element being turned into has fallen back. If the element being turned into is aft of line abreast at the start of the turn, there is a much higher opportunity for conflict and all players must use extreme caution. Vertical stack between the element leads minimizes the opportunity for conflicts. However, the primary means of deconfliction is visual lookout.

6.41. Four-Ship Wall Formation. The four-ship wall formation (**Figure 6.23**) is four aircraft in Line Abreast (LAB) tactical formation. To establish the formation, all flight members fly LAB tactical formation. The wingmen (Numbers 2 and 4) fly LAB off their respective element leads. Lead should brief specific stack guidance for all wingmen.

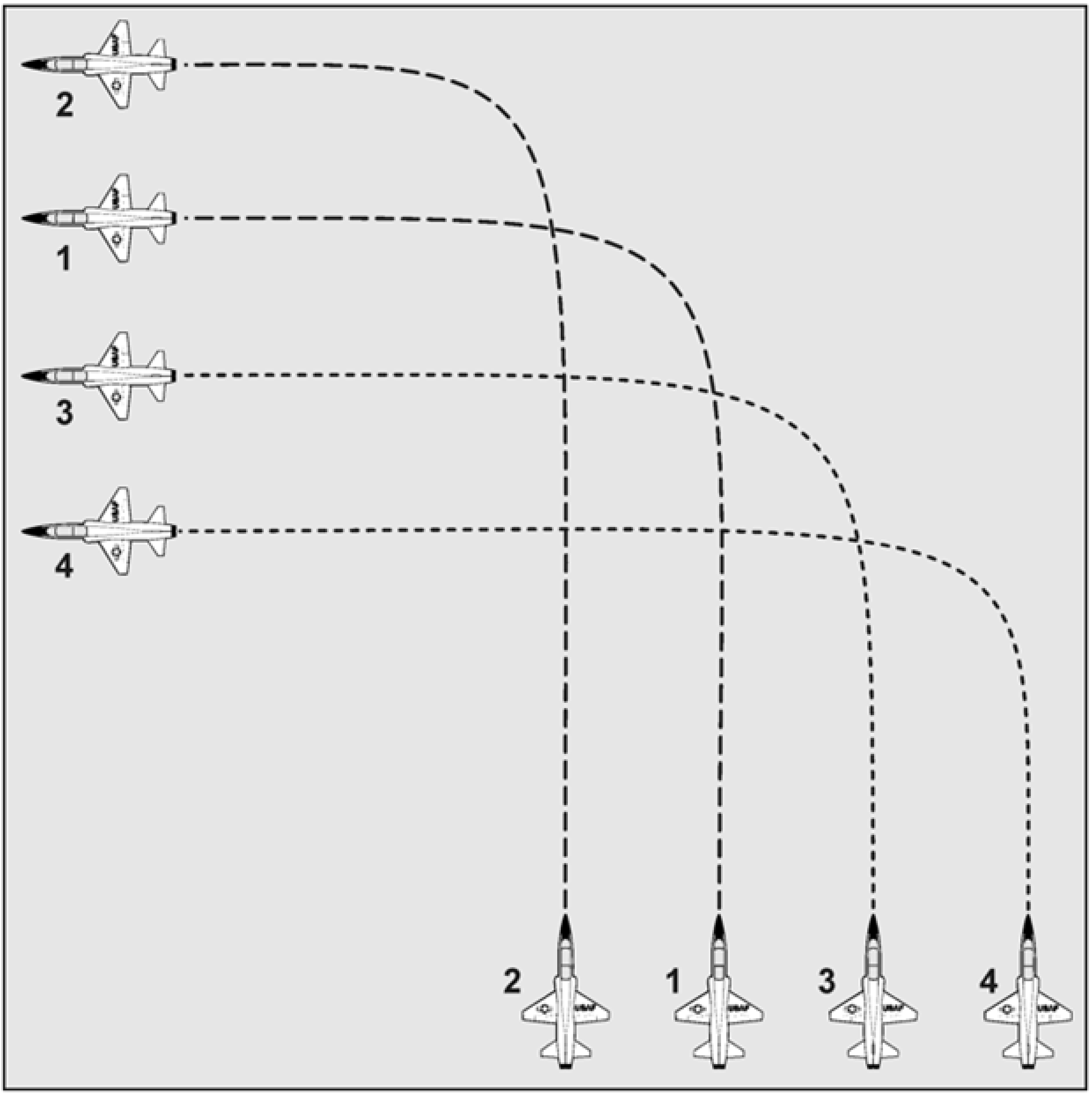
Figure 6.23. Four-Ship Wall Formation.



6.42. Four-Ship Wall Turns:

6.42.1. Delayed turns (**Figure 6.24**) are executed similar to a two-ship tactical. Turns are directed by a radio call or visual signal. If lead gives the signal requiring Number 4 to be the first to turn, Number 3 should repeat the signal down to Number 4. The wingman on the outside of the turn (the side opposite of the turn direction) flies a contract 90-degree turn, and each pilot in succession uses two-ship tactical references and adjustments to execute a contract 90-degree turn. As Number 1 completes the turn, wingmen maneuver to regain position.

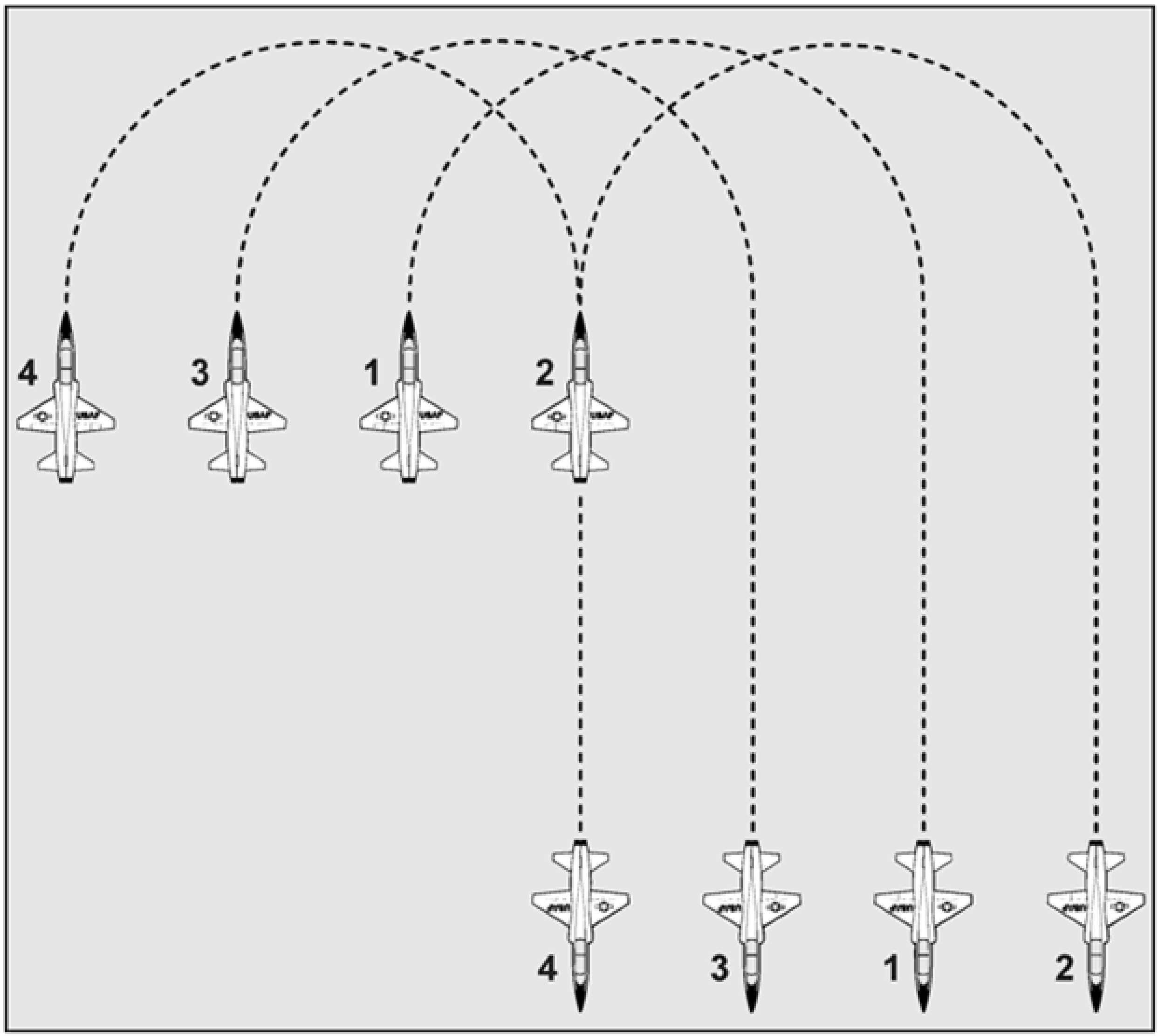
Figure 6.24. Four-Ship Wall Delayed Turn.



6.42.2. As in fluid four, conflicts are minimized if all aircraft are relatively line abreast at the start of the turn. If aircraft have fallen back, the potential for conflicts is increased.

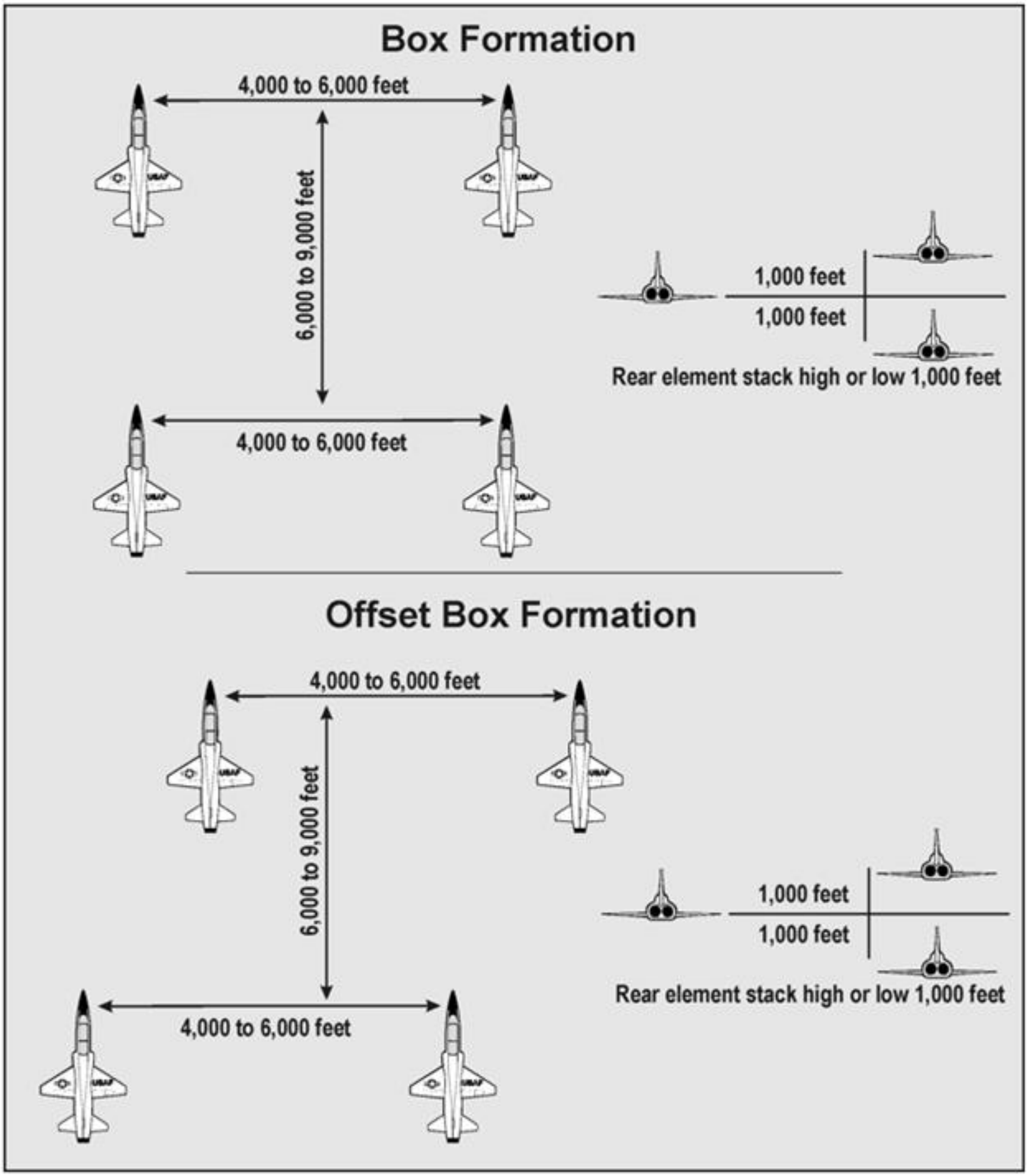
6.42.3. Hook turns are tactical turns executed by all members of the formation simultaneously, resulting in a line abreast formation heading approximately 180 degree from the original heading (**Figure 6.25**) Potential for conflicts during hook turns increases if flight members do not fly the contract turn causing the turn radii to be different.

Figure 6.25. Four-Ship Wall Hook Turn.



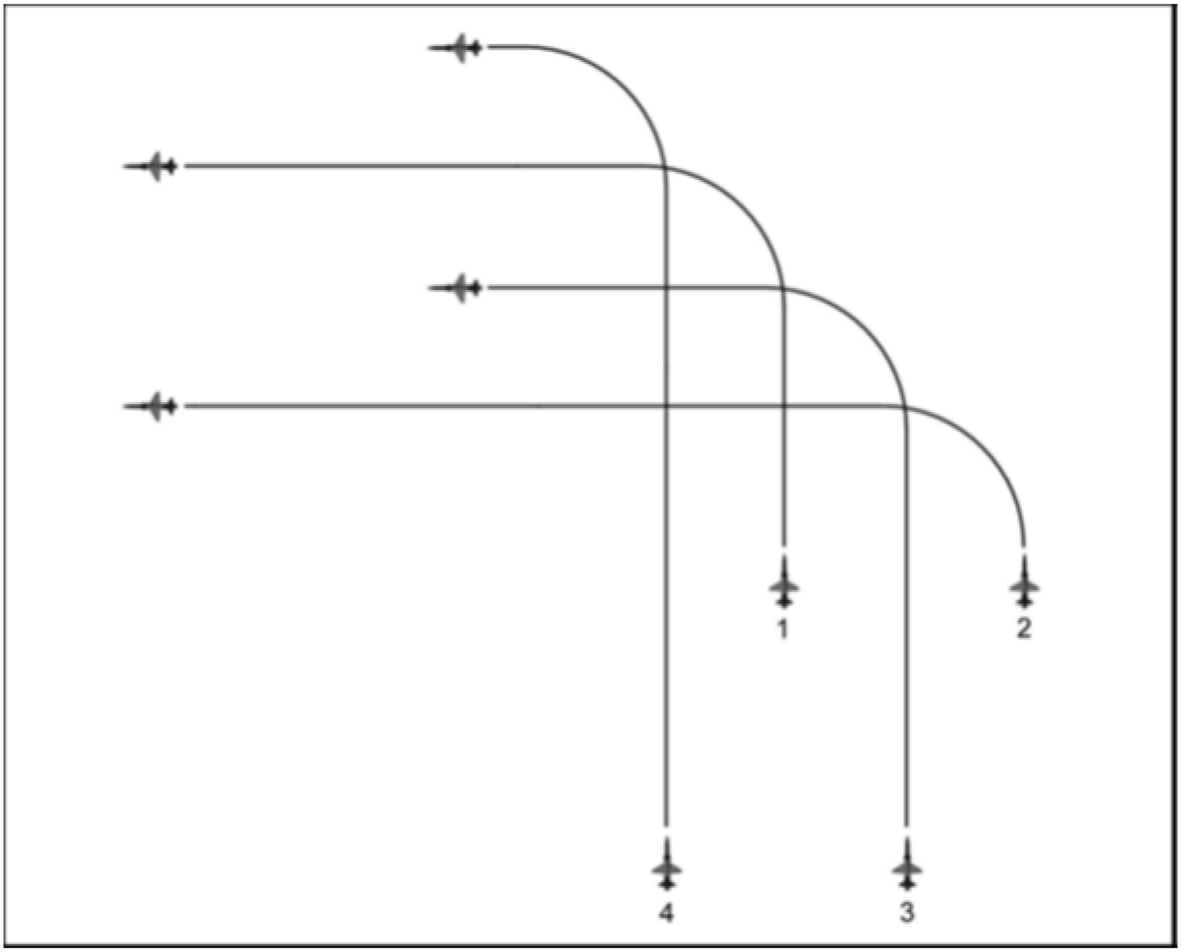
6.43. Four-Ship Box and Offset Box Formations. The four-ship box formation (**Figure 6.26**) is essentially two elements flying a line abreast tactical separated in trail by 6,000 to 9,000 feet. The rear element can fly directly in trail of the lead element (box) or offset the lead element (offset box) at lead's discretion. Generally, by flying offset box, it is easier for all flight members to maintain visual contact with one another. The rear element should normally stack either high or low from the lead element, based on the brief or environmental conditions, unless required to maintain level because of weather or airspace restrictions. Cockpit visibility from the lead aircraft and the small size of the T-38 can make visibility between the front and rear elements a challenge because of environmental conditions and range. This may result in the rear element padlocking on the lead element to maintain visual.

Figure 6.26. Box and Offset Box Formations.



6.44. Box Turns. Lead directs delayed 45and 90-degree turns with a radio call or visual signal. Each element performs a standard delayed turn (**Figure 6.27**) with Number 3 turning the trailing element to finish in the correct position relative to the leading element.

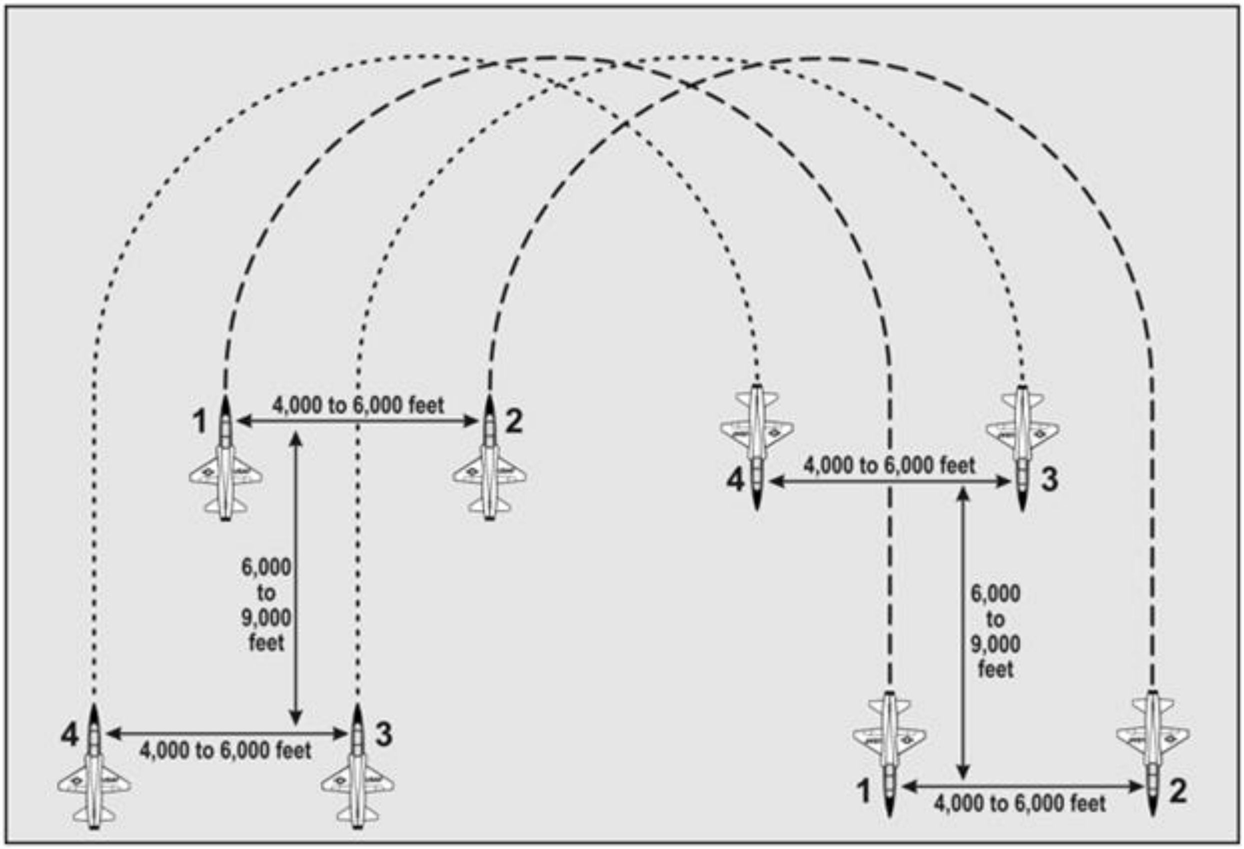
Figure 6.27. Offset Box Delayed Turn.



6.44.1. For turns in box, the rear element must delay for several seconds prior to initiating their turn. One technique is for the trailing element to attempt to turn over the same geographical point or the "same point in the sky." For turns in offset box, the timing for the trailing element's turn could vary from 3 to 4 seconds (when turning away from the rear outrigger) to 7 to 10 seconds (when turning into the rear outrigger).

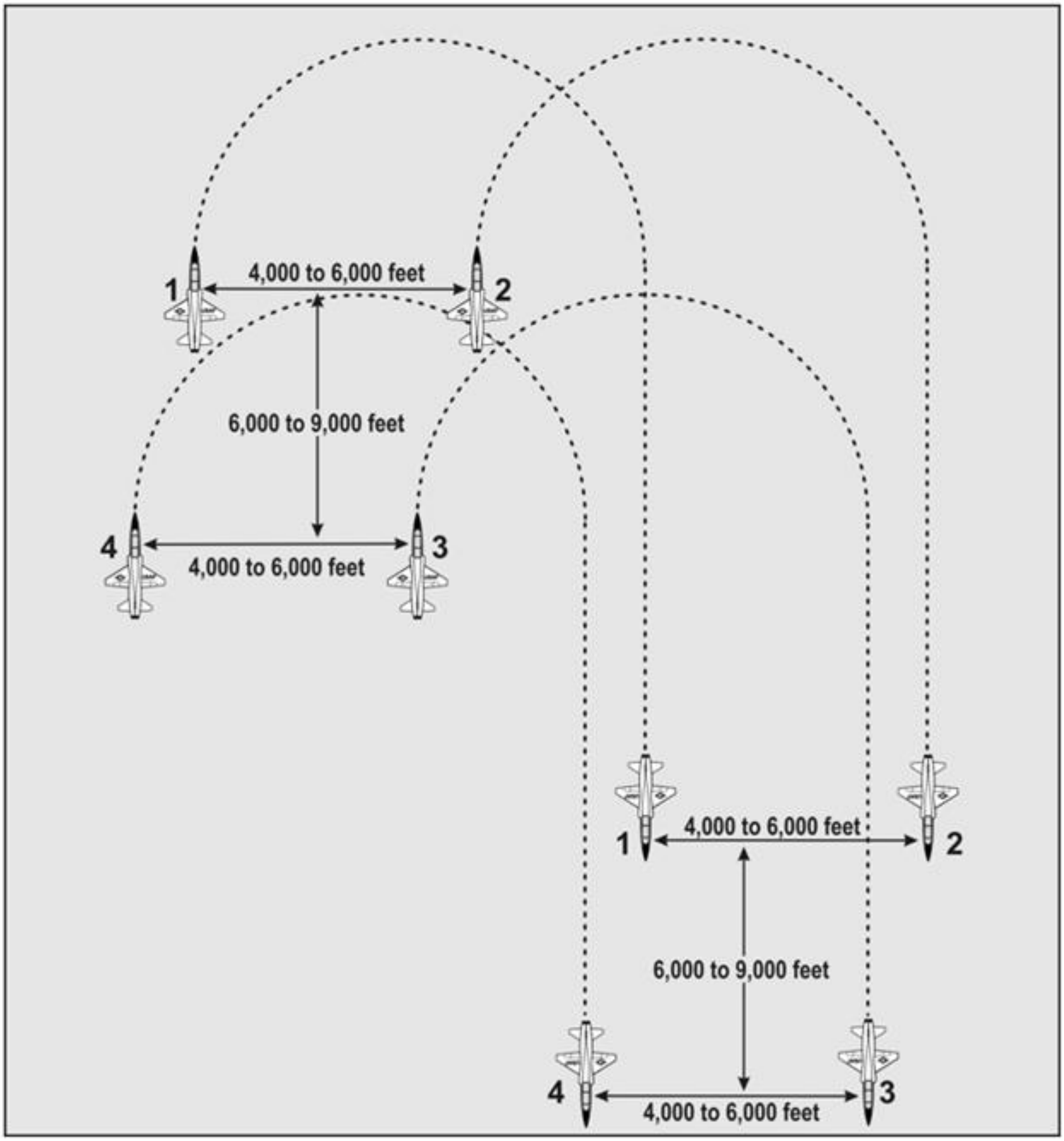
6.44.2. For hook turns in box or offset box, lead directs the turn with a radio call ("Card 21, hook left/ right"). The standard hook turn while in box formation is for the second element to delay, so as to remain in trail (delayed turn) (**Figure 6.28**) Each element performs a contract hook turn, with all four pilots turning in same direction. Number 3 delays momentarily prior to turning the second element to complete the turn in trail of the lead element. (Generally, the trailing element must start their turn before the lead element passes.) If starting level with the lead element, the trailing element must immediately climb or descend to establish vertical deconfliction.

Figure 6.28. Offset Box Hook Turn.



6.44.3. If lead intends all aircraft to simultaneously hook, thereby placing the trailing element in front, he or she will call for an in-place hook turn ("Colt 41, in-place hook left/right") (**Figure 6.29**) This will momentarily put the trailing element in front of lead element, but a second in-place hook turn in either direction will put the four-ship back in standard box formation. One possible application of an in-place hook turn is while accomplishing a G-awareness exercise.

Figure 6.29. In-Place Hook Turn.



6.45. Rejoins:

6.45.1. Overview. The basic tactical rejoin concepts also apply to three- and four-ship formations. All three- and four-ship tactical rejoins will be called on the radio and acknowledged.

6.45.2. Straight-Ahead Rejoins. Wingmen will join on lead as described in **paragraph 6.38.2** (straight-ahead tactical rejoin). Wingmen will not cross lead's 6 o'clock during a straight-ahead tactical rejoin. They will join in sequence and fly no closer than 500 feet to the preceding aircraft until the preceding aircraft are in position.

6.45.3. Tactical Turning Rejoins. In a four-ship tactical formation, Number 2 rejoins to the inside of lead’s turn, Number 3 rejoins to the outside of lead’s turn, and Number 4 rejoins to the outside of Number 3. Wingmen will rejoin in sequence and fly no closer than 500 feet to the preceding aircraft until the preceding aircraft are in position. Number 4 may use reasonable pursuit on Number 3 during the rejoin. Each wingman is responsible for keeping the preceding aircraft in sight and should avoid becoming a conflict or hazard to formation aircraft ahead or behind.

6.46. Three-Ship Options. Although rare, maintenance problems will occasionally cause one aircraft to “fall out,” leaving a three-ship. Specific details—deputy lead, call sign changes, positions to fly, planned position changes, etc.—should be briefed by lead for each mission.

Section 6D—Fluid Maneuvering (FM)

6.47. Objectives. FM is an advanced building block that introduces the concepts and skills required in future medium-range basic fighter maneuvers (BFM). FM builds on the short-range maneuvering practiced in extended trail by requiring the understanding of turn circle geometry and the creative use of pursuit curves and energy management to close from medium to short range. The objectives of FM are to:

6.47.1. Introduce and practice the administrative setups, terminations, and resets for medium-range BFM.

6.47.2. Introduce and practice the application of air-to-air rules of engagement.

6.47.3. Practice recognizing and solving problems of range, closure, aspect, angle-off, and turning room from a medium-range, simulated “offensive” position behind a cooperative aircraft flying a scripted training profile.

6.47.4. Practice setting and controlling aspect angle and maintaining briefed training parameters for the training aircraft.

6.47.5. Practice maneuvering to, recognizing, and stabilizing in the extended trail cone from a position well outside that cone, simulating the recognition of a weapons engagement zone.

6.48. Responsibilities:

6.48.1. Collision Avoidance. Flight members must be vigilant with regard to clearing their flightpath and recognizing and avoiding the prebriefed minimum range limitation (“the bubble”).

6.48.2. Training Rules and Rules of Engagement. Flight members must strictly adhere to prebriefed rules of engagement and special instructions.

6.48.3. Fuel Awareness. Because FM generally involves higher power settings for longer periods of time, pilots must continually monitor their fuel state to prevent overflying joker or bingo. Leads will call for an ops check before and between engagements.

6.48.4. Setup Standardization. During BFM training, the need for setup standardization is critical to the reconstruction, debriefing, and assessment of desired learning objectives. It follows, therefore, that the training aircraft must not deviate from the prebriefed profile ("contract"). Leads are primarily responsible for accurately briefing and aggressively controlling these aspects of FM. The pilot in the maneuvering aircraft must strive to be in the correct starting position and must not call "ready" until the prebriefed starting parameters can be achieved.

6.49. FM Exercise. In addition to fulfilling the common responsibilities in **paragraph 6.46**, the two pilots in an FM exercise have distinctly different roles. (See **paragraph 6.50** through **paragraph 6.62** for details of these roles.)

6.50. Training Aircraft. Although the primary training objectives are for the maneuvering aircraft pilot, there are significant training opportunities for the training aircraft. These include over-the-shoulder SA, plane-of-motion assessment, lift vector control, floor awareness, G-awareness, and energy management. The responsibilities of the pilot in the training aircraft include adjusting bank or back stick pressure to "set" the aspect; monitoring the maneuvering aircraft; and, most importantly, flying the prebriefed parameters ("the contract").

6.51. Maneuvering Aircraft. FM's primary objectives are for the pilot in the maneuvering aircraft. The responsibilities of the pilot in the maneuvering aircraft include being in level, pure pursuit to start, helping the training aircraft pilot adjust the starting aspect, and remaining vigilant for high over-G potential situations. Between setups, the maneuvering aircraft should maintain or regain the prebriefed position until directed otherwise by lead while climbing at MIL power or 350 KIAS back into the briefed starting block.

6.52. FM Exercise Levels. The building block approach is used in FM training by decreasing the maneuvering limitations of the training aircraft as the wingman's proficiency increases (**Table 6.2**)

Table 6.2. FM Exercise Levels (Training Aircraft).

<table>
<tr><th rowspan="2">ITEM</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
<tr><th>FM Level</th><th>Maneuver</th><th>Gs</th><th>Airspeed</th><th>Power</th></tr>
<tr><td>1</td><td>1</td><td rowspan="2">Level to slightly descending</td><td>2 to 4 (Note 1)</td><td>400 (Note 1)</td><td rowspan="3">550 EGT</td></tr>
<tr><td>2</td><td>2</td><td rowspan="2">2 to 4</td><td rowspan="3">250 to 400</td></tr>
<tr><td>3</td><td>3</td><td>Slight climb/descent (MAX 120 degrees bank)</td></tr>
<tr><td>4</td><td>4 (Note 2)</td><td>Slight climb/descent (MAX 120 degrees bank)</td><td>2 to 5</td><td>Military</td></tr>
<tr><td colspan="6">Notes:
1. Maintain constant G and airspeed. Increase G as proficiency allows.
2 .IP demo or continuation training only. The wingman is allowed use of power up to MAX afterburner.</td></tr>
</table>

6.53. Special Instructions, Training Rules, and Rules of Engagement. These three terms intertwine in their application to training scenarios. Violation of training rules has serious implications for flight safety. Adherence to training rules is essential to a disciplined combat aviator. AFI 11-214, *Air Operations Rules and Procedures*, mandates numerous training rules, which have been developed over years of combat aviation training and are designed to provide a safe, effective training environment. The term "rules of engagement" has real-world combat applications, but is also commonly used in training. The following rules of engagement apply:

6.53.1. The floor is 1,000 feet above the bottom of assigned airspace.

6.53.2. Power setting—MIL power or less. See **Table 6.2**.

6.53.3. The "bubble"—500 feet (1,000 feet for mission qualification training). (If a transition to extended trail is briefed, "bubble" rules of engagement are no longer applicable after the "in" call.) When the maneuvering aircraft closes to approximately 2,000 feet and approaches a stabilized position, the training aircraft will begin a level to slightly descending turn, maintaining constant G and airspeed.

6.53.4. The training aircraft will not execute turn reversals after the call to begin maneuvering.

6.54. Starting Parameters. A T-38's 400 KIAS, 4 G turn radius at 15,000 feet MSL is approximately 5,200 feet. Therefore, the FM exercise begins at or slightly outside the training aircraft's turn circle, as follows:

6.54.1. Altitude block—15,000 to 17,000 feet MSL. (This may be adjusted.)

6.54.2. Airspeed—400 (± 10) KIAS.

6.54.3. Maneuvering aircraft pursuit—pure pursuit, stacked level.

6.54.4. Aspect angle—30 to 45 degrees or as briefed. The maneuvering aircraft is just forward of the training aircraft's wingtip. (This may be adjusted for training objectives.)

6.54.5. Range—6,000 feet.

6.55. Setup Comm. Each setup should be preceded by an ops check, a descriptive preparatory call ("Poison 21, standby FM level 2"), and "ready" calls from both pilots. The call to begin maneuvering may be a pre-briefed responsibility of either the training aircraft pilot or the maneuvering aircraft pilot.

6.56. FM Exercise Setups. There are three common ways to set up the FM exercise; from directed positions, from a pitchout, or from a tactical formation, as follows:

6.56.1. From Directed Positions. This option is a little more comm-intensive, but is especially efficient for dealing with weather-restricted airspace. Lead maneuvers or directs the flight as necessary back into the block and back to clear airspace for the next setup. The maneuvering aircraft simply maintains a directed position until directed to a different position by the flight lead.

6.56.2. From a Pitchout. Lead can accelerate in a route position to starting airspeed before the pitchout or direct acceleration afterward. The maneuvering aircraft delays to roll out 7,000 to 9,000 feet (about 5 to 6 seconds) behind lead. The training aircraft turns to acquire a visual and set the desired aspect. When the range decreases to 6,000 feet, the call is made to begin maneuvering.

6.56.3. From a Tactical Formation:

6.56.3.1. After maneuvering into the block, completing setup admin, and acknowledging the descriptive call for the next setup, the maneuvering aircraft slides out to 7,000 to 9,000 feet line abreast. If transitioning from 400 KIAS tactical, no acceleration maneuver is required. If transitioning from a 350 KIAS climb or tactical, an acceleration maneuver is required.

6.56.3.2. After the "ready" calls, lead directs a check turn (for example, "Sting 11, check 45 left"). The training aircraft normally turns about 45 degrees away from the maneuvering aircraft, but may adjust as necessary. The maneuvering aircraft continues the turn as needed to attain pure pursuit. The training aircraft reverses the turn, acquires a visual on the wingman, and adjusts bank or back stick pressure to "set" the desired aspect. When range decreases to 6,000 feet, the call is made to begin maneuvering.

6.57. Transition to Extended Trail. If briefed, FM may culminate with a transition to an extended trail exercise. A radio call from the maneuvering aircraft (for example, "Sting 2's in") usually marks the transition, after which both pilots will adhere to extended trail parameters and restrictions.

6.58. Resets. The reset procedures used in the T-38 are very similar to those used in fighter training. As such, they deserve considerable emphasis and attention. The time and fuel used between setups cannot be wasted. Priorities are as follows:

6.58.1. Lead. Lead will stay visual and clear, remain predictable initially, select MIL power and attain or maintain 350 KIAS for the climb, and not hesitate to be directive with the wingman.

6.58.2. Wingman. The wingman will stay visual and clear, maintain extended trail until directed otherwise, select MIL power and attain or maintain 350 KIAS for the climb, and deconflict as necessary.

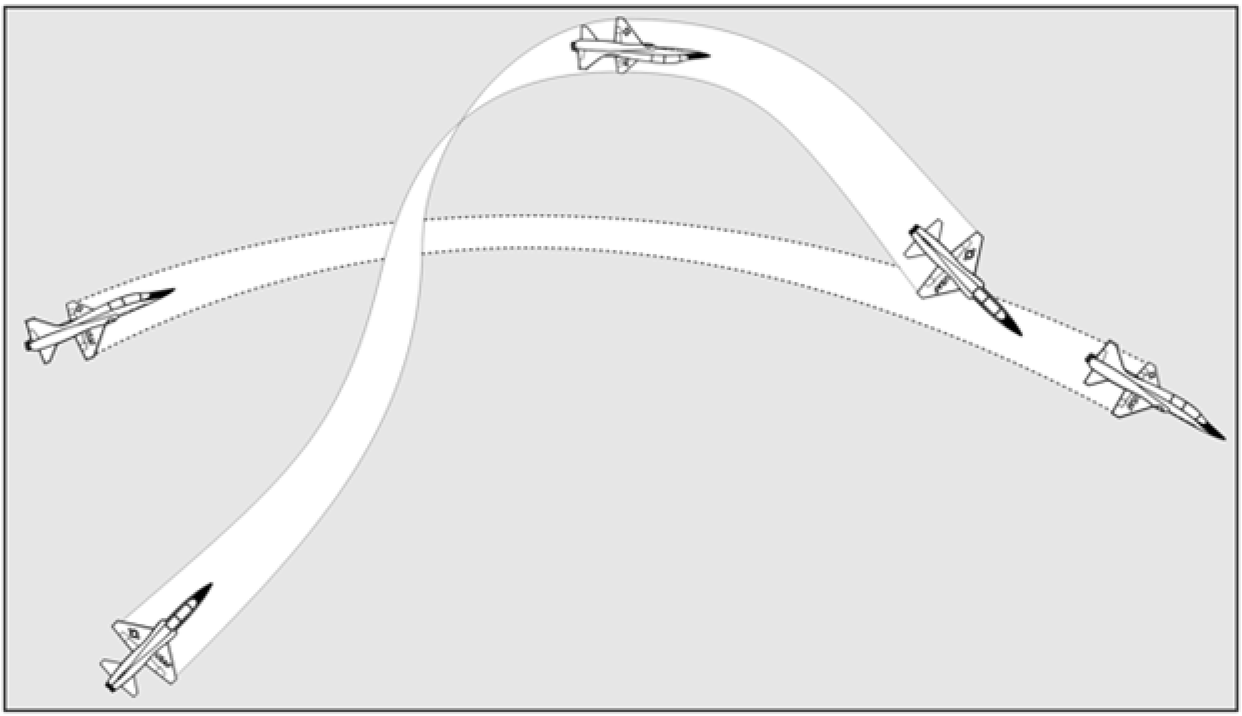
6.59. Initial Moves:

6.59.1. Finding the Turn Circle. If the call to begin maneuvering comes right at 6,000 feet, the opening move is normally a delay to preserve turning room. From 6,000 feet, just a small delay will preserve the optimum turning room for the offensive break turn, which should be executed on—or close to—the training aircraft's turn circle. Use caution during this delay to ensure the airspeed does not increase beyond that desired for the break turn. The aspect of the training aircraft will increase during this delay. The delay may be accomplished in-plane or out of plane. (Many pilots prefer to create some vertical turning room as well by adding a slight climb to their delay.)

6.59.2. Break Turn. A break turn too early—from inside the training aircraft's turn circle—will cause a cut across training aircraft's turn circle, which quickly decreases range, but also creates very high aspect. A break turn too late will waste turning room, cause a turn circle overshoot, and result in excessive lag and range. To execute the first break turn, roll to place the lift vector approximately on or slightly below the training aircraft and smoothly apply back stick pressure in a symmetrical pull to stop the training aircraft's LOS across the canopy. The goal of the first break turn is to place the maneuvering aircraft on the training aircraft's turn circle and decrease range while preserving enough energy and turning room to solve subsequent geometry problems. Heightened G-awareness and careful reference to the G-meter are required to prevent over-Gs during the first break turn.

6.60. Lag Reposition. The lag reposition (**Figure 6.30**) is used to generate turning room to solve excessive closure and angle-off problems.

Figure 6.30. Lag Reposition.

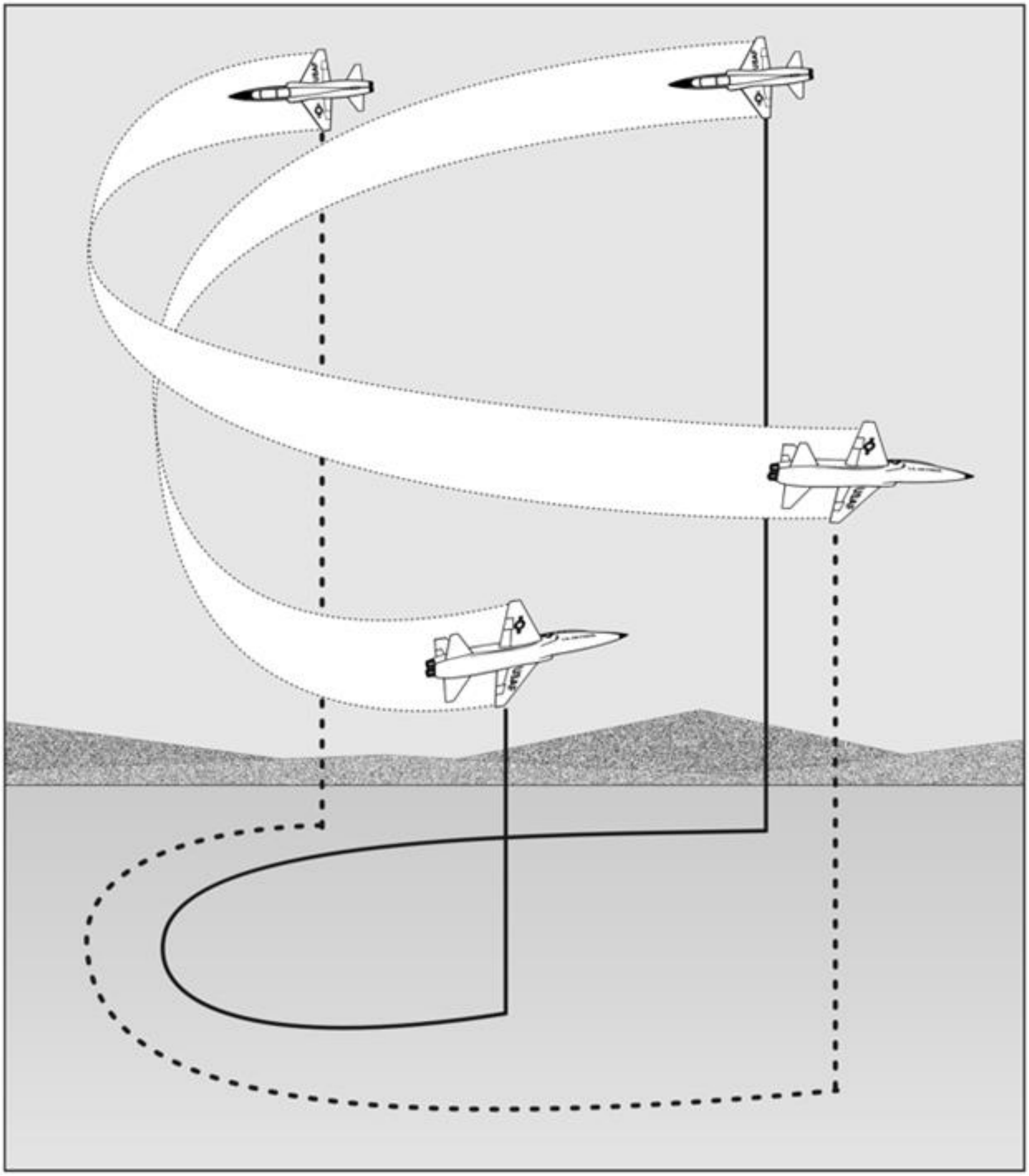


6.60.1. Position your lift vector up and out of the training aircraft's POM. (The out-of-plane angle required will vary. In cases where aspect is decreasing too slowly, a lift vector position of more than 90 degrees to the training aircraft's flightpath may be necessary). Add back stick pressure as required to generate turning room.

6.60.2. Once sufficient turning room has been achieved, crisply roll back to place the lift vector on or below the training aircraft and pull to attempt to align fuselages. Use the radial G and out-of-plane turning room made available by the lag reposition to help establish lead pursuit. Once established in the extended trail cone, call "in." The entire lag reposition is normally flown at the maximum allowable power setting.

6.61. Lead Reposition. The lead reposition (**Figure 6.31**) is used to generate closure to decrease range while preserving or building energy.

Figure 6.31. Lead Reposition.

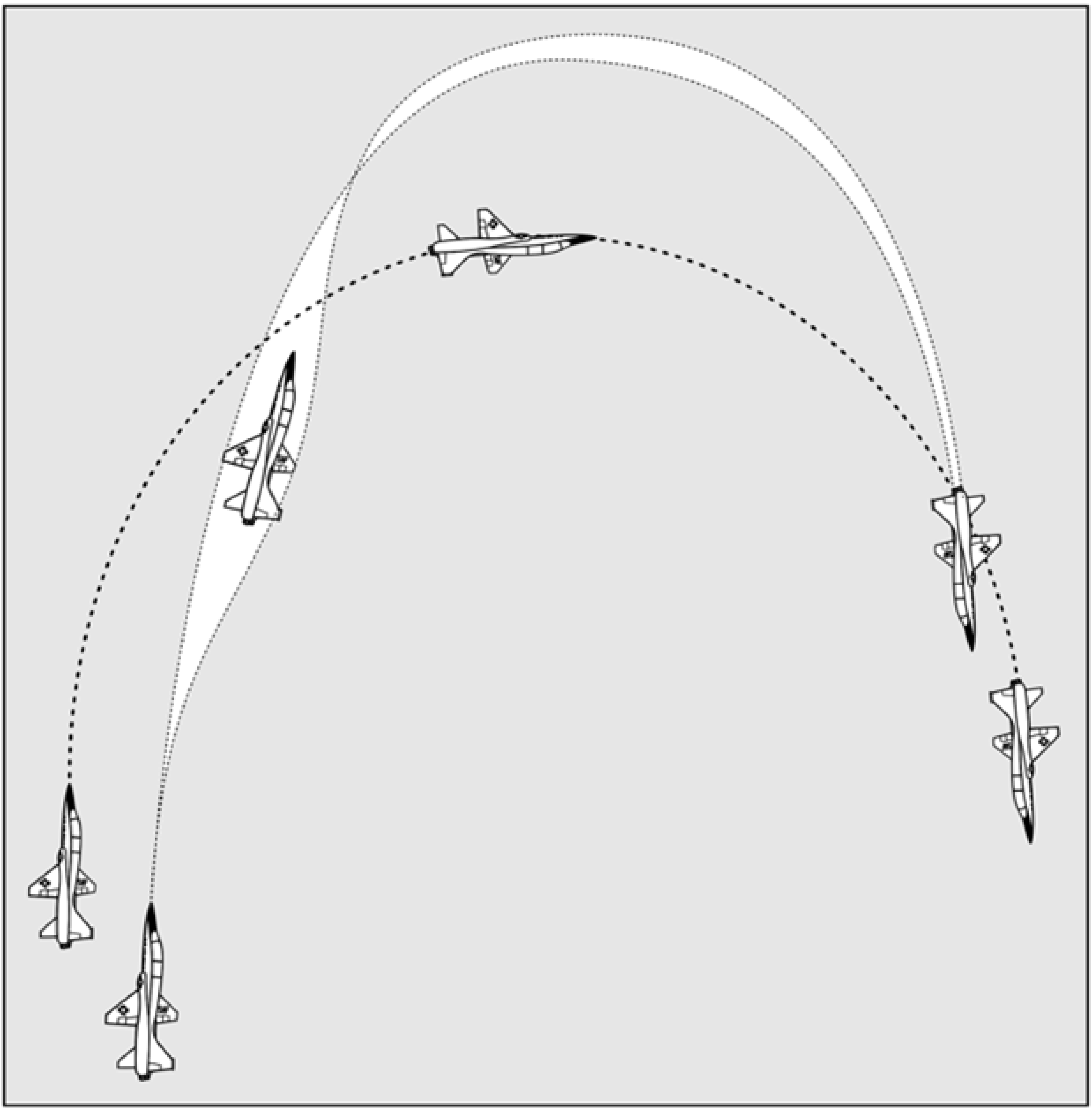


6.61.1. Place the nose and lift vector so that you pull lead pursuit in a POM below the training aircraft. (How much lead and/or descent will vary with range, closure, the training aircraft's LOS, and your energy state.) This out-of-plane maneuver uses turning room below lead. Analysis of the training aircraft's LOS will tell you whether you need more or less lead pursuit. When desired range or closure are reached, a lag maneuver or reposition may be required to preserve turning room for realigning fuselages. Once established in the extended trail cone, call "in."

6.61.2. Until the end-game, the lead reposition is normally flown at the maximum allowable power setting. Note that the "picture" during a lead reposition may at times look very similar to that of a turning rejoin.

6.62. Quarter Plane. The quarter plane (**Figure 6.32**) is an exaggerated lag reposition used as a last-ditch maneuver to control closure and prevent a 3/9 line overshoot (often referred to as "preserving 3/ 9 line") at close ranges and high LOS rates.

Figure 6.32. Quarter Plane.



6.62.1. Crisply roll out of plane and pull to the training aircraft's high 6 o'clock. The pull out of plane is at least—and often more than—90 degrees from the training aircraft's POM, but the amount depends on closure, range, and aspect. This pull to the training aircraft's "high six" reduces closure and aspect to prevent the loss of the 3/9 line advantage.

6.62.2. You will probably lose sight momentarily during a quarter plane. A momentary power reduction may be required, but leaving the power back at high AOA with the nose up can quickly result in an excessive loss of energy.

6.62.3. Following the pull, unload and crisply roll to regain a tally and analyze your new position. Key on the training aircraft's LOS. If the training aircraft is still moving aft, the closure problem is probably not yet solved. If the training aircraft is stopped or moving forward, closure is under control. Once established in the extended trail cone, call "in."

Section 6E—Handling Abnormal Situations in Formation

6.63. Takeoff Aborts:

6.63.1. Formation Takeoff:

6.63.1.1. If an abort becomes necessary, maintain aircraft control, ensure separation from the other aircraft by maintaining your side of the runway, and make a radio call as soon as practical ("Flank 2 is aborting, BARRIER, BARRIER, BARRIER"). However, do not sacrifice aircraft control to make a radio call.

6.63.1.2. During a formation takeoff, there will normally be no sympathetic aborts within the element after brake release. Sympathetic aborts can create situations where a good aircraft is risking simultaneous barrier engagement, hot brakes, or blown tires.

6.63.1.3. During an abort situation, the aircraft continuing the takeoff will maintain its side of the runway, select full afterburner, and execute a normal single-ship takeoff. If lead determines both aircraft should abort, he or she will direct the wingman to abort. For example, lead will transmit, "Sting 21 flight, ABORT, ABORT, ABORT." Being in minimum afterburner and still overrunning lead could be the first indication that lead is aborting. If this occurs, accomplish a separate takeoff.

6.63.2. Interval Takeoff. If you abort as lead, make a radio call to your wingman. It is difficult for the wingman to recognize an abort using only visual cues. If, as the wingman, you have not released brakes, reduce your power and hold your position until lead clears the runway. If you have started the takeoff roll, but are below 100 knots, consider aborting because you may not have sufficient spacing to takeoff behind lead. If you are above 100 knots, you should continue the takeoff, using MAX afterburner.

6.63.3. Element Abort. If an element abort is necessary, each aircraft must maintain its respective side of the runway and make every effort to stop prior to the end of the runway. Any aircraft requiring a barrier engagement should transmit its call sign and announce, "BARRIER, BARRIER, BARRIER." If neither aircraft can stop prior to the end of the runway, the first aircraft to the barrier will engage the barrier and the second aircraft will take any necessary action to prevent barrier engagement, to include departing the runway surface.

6.64. Airborne Emergencies. As much as possible, maintain formation integrity for all airborne emergencies. If any aircraft malfunction occurs while in close formation, ensure aircraft separation before handling the emergency. The pilot of an aircraft experiencing an abnormal situation will advise lead of the problem, his or her intentions, and assistance required.

6.64.1. Lead. As a minimum, offer the lead to a wingman as soon as you realize he or she has an aircraft malfunction. Except in IMC, never fly closer than route formation after giving up the lead. If the wingman refuses the lead, try to pass the lead on recovery and on final with clearance to land or as the situation dictates. Except in unusual circumstances, do not land in formation with a disabled aircraft. If the wingman is able to transmit and receive with the radio, give him or her verbal assistance as necessary. Follow the preflight briefing instructions for emergencies so the wingman knows what to expect.

6.64.2. Wingman. When an aircraft malfunction is discovered, call "knock-it-off" and then inform lead of the problem. Normally, if you are able to communicate with outside agencies and navigate, take the lead when offered. As much as possible, avoid flying the wing position with an emergency. If you must fly the wing position with an emergency, fly no closer than route spacing when weather allows.

6.64.3. Radio Failure. An aircraft experiencing radio failure will normally assume or retain the wing position. If experiencing radio failure as lead, put the wingmen in route and give the appropriate AFPAM 11-205 visual signal. Then pass the lead to either Number 2 or Number 3 as appropriate. If experiencing radio failure as a wingman while in close or route formation, maneuver within close or route parameters to attract the attention of another flight member and give the appropriate visual signals. In other positions, do not rejoin closer than 500 feet. Rock your wings to gain lead's attention and wait for a rejoin signal from lead. When signaled, rejoin as close as necessary to pass the appropriate visual signals.

6.64.4. Lost Wingman Procedures:

6.64.4.1. Lead. To minimize the possibility of a lost wingman situation, brief pertinent IMC procedures during the preflight briefing. Bring all wingmen into fingertip spacing and reform any three- or four-ship formation into fingertip prior to entering IMC.

6.64.4.2. Wingman. If lead fails to coordinate for a separate clearance, contact the controlling agency. Keep in mind that lost wingman procedures do not guarantee obstacle clearance when close to the ground. Therefore, the pilot who is executing lost wingman procedures is responsible for terrain and obstacle clearance.

6.64.5. Bird Strike. If a bird strike appears imminent, do not hit the other aircraft in an effort to miss the bird. The primary concern is still aircraft separation. If a bird strike does occur, ensure aircraft separation before handling the emergency. Lead should consider the option of a wing landing if the rear cockpit pilot must land the affected aircraft and forward visibility is severely restricted.

6.64.6. Lost Sight. In some cases, losing sight of the other aircraft does not require a breakout or lost wingman procedure because sufficient spacing already exists. If the other aircraft is not in sight when anticipated, use the following procedures:

6.64.6.1. Notification. Notify the other aircraft of your situation ("Sting 2's blind"). In some cases, heading, altitude, or turn information may also be appropriate with this call. If only lead is blind, the call "Sting 1 is blind" is posed as a question for the wingman, who responds with his or her position ("Sting 2, visual, your right 3 o'clock, high").

6.64.6.2. One Aircraft is Blind. If the other aircraft has not lost sight, transmit "visual" with a relative position to the blind aircraft. If lead is the blind aircraft, but the wingman has lead in sight, lead has the option to direct a rejoin or continue to search for the wingman, based on the response to a "blind" call.

6.64.6.3. Both Aircraft are Blind. If both aircraft have lost sight, lead will immediately ensure a minimum of 1,000 feet altitude separation. Both aircraft will maintain this separation until one aircraft regains a visual. The aircraft that gains the visual may direct the other aircraft to rock its wings for positive identification. The aircraft with the visual is responsible for maintaining separation and may direct the other aircraft to maneuver to maintain the visual. Once positive identification has been achieved, lead may direct a rejoin.

6.64.6.4. Three- or Four-Ship Formations. All members of a formation should strive to maintain visual on all other members of the formation. However, the wingman's primary responsibility is to maintain visual on their element lead. Number 3 is responsible to maintain visual on lead. If a member of the flight loses sight of any other aircraft, call blind or visual with the number of aircraft seen ("Snake 4, blind" or "Snake 4, visual two aircraft"). This call may be delayed if there is no doubt as to the identification of the aircraft with which they are visual, and no conflict exists. For instance, in wall or offset box, if a wingman loses sight of the opposite wingman, but has maintained visual on his element lead and lead, a "blind" call would not be required. If any doubt exists, call "blind."

6.64.7. Midair Collision. If a midair collision occurs between formation members, under no circumstances will they act as chase ships for each other.

6.64.8. Ejection. If one aircraft in a formation must perform a controlled ejection, the chase ship will fly no closer than 1,000 feet abreast of the disabled aircraft.

6.64.9. Spatial Disorientation:

6.64.9.1. Lead. If you experience spatial disorientation as lead, immediately advise the wingmen and, if possible, transfer aircraft control to the other crewmember. If transfer of aircraft control is not an option, confirm attitude with the other crewmember or wingmen. If symptoms persist, terminate the mission and recover the flight by the simplest and safest means possible.

6.64.9.2. Wingman. Wingmen experiencing spatial disorientation will advise their other crewmember and/or lead when disorientation makes it difficult to maintain position. The crewmember not in control of the aircraft or lead will advise the wingman of aircraft attitude, altitude, heading, and airspeed. If symptoms persist and conditions permit, lead should establish straight-and-level flight for 30 to 60 seconds and consider passing the lead to the disoriented wingman. If necessary, terminate the mission and recover by the simplest and safest means possible.

6.64.9.3. Three- and Four-Ship. Lead should separate the flight into elements to more effectively handle a wingman with persistent spatial disorientation symptoms. The element with the disoriented pilot should remain straight-and-level while the other element separates from the flight.

Chapter 7

INSTRUMENTS

7.1. Introduction. Instrument flying procedures are described in detail in AFMAN 11-202V3. There will be circumstances when you must rely on your instrument flying ability to operate safely. This chapter will familiarize you with a few of the instrument procedures specific to the T-38.

7.2. Instrument Cross-Check. The control and performance concept is the foundation of good instrument flying. A solid instrument cross-check will use control instruments (attitude indicator and engine tachometers) and performance instruments (altimeter, airspeed indicator, VVI, AOA, and HSI) to:

7.2.1. Establish an attitude and power setting on the control instruments.

7.2.2. Trim until control pressures are neutralized.

7.2.3. Cross-check performance instruments to determine if the established attitude and power settings are providing the desired performance.

7.2.4. Adjust attitude and power setting, using control instruments, and retrim as necessary.

7.3. Prior to Instrument Takeoff (ITO). Update weather conditions and TOLD; review the instrument departure, radar routing, terminal approach NAVAIDs, and radar approach capability at the departure airfield; and review an emergency return plan based on single-engine climb capability and obstacle features of the departure airfield. Set up your NAVAIDs accordingly.

7.4. ITO. The ITO is similar to the contact takeoff except you will transition to instruments as outside visual references deteriorate. Once airborne, establish a wings-level, 5-degree nose-high indication on the ADI and confirm a definite rate of climb. After verifying a positive climb on the altimeter and VVI, retract the landing gear and flaps. **Note:** Use extreme caution when transitioning to instruments during the takeoff. The pitch changes associated with gear and flap retraction in the T-38 may cause momentary disorientation at very low altitude. A proper instrument cross-check is essential to maintain SA during this phase of flight.

7.5. Instrument Departure. In most cases, you will use the restricted MIL power climb schedule for instrument and navigation departures. You must maintain a constant cross-check in order to divide your attention between aircraft control, departure procedures, and checklist duties. This can be accomplished by quickly completing one item at a time and returning to your instrument cross-check in between, with primary emphasis on the ADI.

7.6. Leveloff. The lead point for leveloff, from either a climb or descent, will vary depending on the VVI you are using. The following techniques will help you develop smooth lead points:

7.6.1. With low or moderate climb or descent rates, begin the leveloff at 10 percent of the VVI reading. For example, with a VVI of 2,500 fpm, begin the leveloff 250 feet early.

7.6.2. With a VVI greater than 6,000 fpm, reduce the pitch attitude by one-half at 2,000 feet prior to leveloff and then use 10 percent of the VVI.

7.7. Arc and Radial Intercepts:

7.7.1. Turn Radius:

7.7.1.1. Arc and radial intercept techniques are based on making a 90-degree turn, using 30 degrees of bank in no-wind conditions. Because these techniques are also based on established turns, the slower you roll into 30 degrees of bank, the more you will need to “pad” your lead point. Turn radius lead points for the T-38 in miles can be calculated with the use of the following techniques:

7.7.1.1.1. For higher airspeeds (>300 knots), Mach - 2 = approximate turn radius (in miles), using 30 degrees of bank.

7.7.1.1.2. For slower speeds, 1 percent of IAS = approximate turn radius (in miles), using 30 degrees of bank.

7.7.1.2. These two techniques do not take winds into account. To adjust for less than 90 degrees of turn, use the following techniques:

7.7.1.2.1. For a turn of 60 degrees, use one-half of the calculated lead point.

7.7.1.2.2. For a turn of 45 degrees, use one-third of the calculated lead point.

7.7.1.2.3. For a turn of 30 degrees, use one-sixth of the calculated lead point.

7.7.2. Arc-to-Radial Intercepts. After calculating your lead point, use the 60-to-1 rule to translate the lead point in miles to the lead point in radials. For example:

7.7.2.1. Using the 1-percent technique, flying at 250 KIAS corresponds to a 2.5 nm turn radius. By applying the 60-to-1 rule, on the 10 DME arc where there are 6 radials per mile, use a lead point of 15 radials.

7.7.2.2. At .5 Mach, using the Mach # -2 method, the turn radius is 3 nm. On the 20 DME arc where there are 3 radials per mile, use a lead point of 9 radials.

7.8. Basic Aircraft Control Maneuvers:

7.8.1. Vertical “S” Maneuvers. Fly vertical “S” maneuvers as described in AFMAN 11-202V3, at various airspeeds and configurations. Normally, use 1,000 to 2,000 fpm VVI rates and a 1,000-foot altitude block. The following techniques may be used to anticipate the pitch and VVI changes at different airspeeds:

7.8.1.1. IMN x 1000 = VVI change for a 1-degree pitch change. For example, at .6 IMN, you will get about 600 fpm per degree of pitch change.

7.8.1.2. Miles per minute x 100 = VVI change for a 1-degree pitch change. For example, at 300 KIAS (or about 5 miles per minute), you will get about 500 fpm per degree of pitch change.

7.8.2. Steep Turns. Practicing steep turns builds confidence and instrument skills that sometimes become necessary when 30 degrees of bank is not sufficient for safety or other reasons. Practice steep turns at various airspeeds, using 45 to 60 degrees of bank. AFMAN 11-202V3 describes factors associated with flying steep turns. The pitch changes needed to maintain altitude will be approximately 1 to 1 1/2 degrees for 45 degrees of bank and 2 to 3 degrees for 60 degrees of bank. When intercepting a specific heading, use approximately a 5-degree lead point for 45 degrees of bank and a 10 degree lead point for 60 degrees of bank.

7.8.3. Confidence Maneuvers. As the name implies, these maneuvers build confidence and teach aircraft control throughout wider ranges of pitch, bank, and airspeed. They help develop skills required to recover from unusual attitudes, using the ADI during extreme pitch and bank attitudes. Perform these maneuvers as described in AFMAN 11-202V3. Use the following entry parameters for confidence maneuvers:

7.8.3.1. For a wingover, use 350 KIAS and 95 percent rpm.

7.8.3.2. For an instrument aileron roll, use a minimum of 300 KIAS and 85 percent rpm.

7.8.4. Unusual Attitudes. Refer to AFMAN 11-202V3 for procedures for recovering from instrument unusual attitudes.

7.9. Arrival Checks. AFMAN 11-202V3 describes how to prepare for an instrument arrival or approach. Techniques for accomplishing arrival checks include the following: (NOTE: Items in bold and italics are mandatory checks required by AFMAN 11-202V3.)

7.9.1. "WHOLDS" Check. **Figure 71** shows the definition of the acronym "WHOLDS." This check is meant to be a memory aid to ensure required items are accomplished en route to an initial approach fix (IAF) or holding fix or prior to beginning an en route descent. It may also be used between approaches. If an item such as a descent check or obtaining the weather has been accomplished, it does not need to be reaccomplished between approaches.

Figure 7.1. WHOLDS—A Memory Aid.

Weather. ***Recheck weather (if appropriate).*** Determine the landing runway and altimeter setting and ensure the weather and airfield are suitable for the approach.

Holding or Heading and attitude systems. Obtain clearance to hold, review the holding pattern, and determine the appropriate point to slow to holding airspeed. Review holding entry techniques to determine the most appropriate entry. ***Check heading and attitude systems.***

Obtain clearance for the approach and coordinate for climbout instructions if applicable.

Letdown plate review or Lost Comm. ***Review the IAP for the type of final planned.*** Refer to AFMAN 11-202, Volume 3, for approach review techniques. Set up NAVAIDs as appropriate. ***Coordinate lost communication procedures (if required)*** and consider a plan for a backup approach.

Descent check. Items on the descent check, such as altimeter settings and airspeeds, may need to be updated in the course of the approach. ***Check the heading and attitude systems.***

Speeds. Calculate final approach speeds and review configuration.

7.9.2. "T" Check. This check is a visual aid confirming the cockpit is prepared for the approach. It can be used as a final check or double-check to ensure items are properly set up. The top of the "T" is the airspeed indicator, attitude systems, and altimeter. Double-check that the airspeed bug is set, attitude systems are checked (both main ADI and standby AI), and altimeter setting is correct. The vertical bar of the "T" includes the HSI, radios, and NAVAIDs. Confirm the heading system is good, course and heading bug set on the HSI, and the radio and NAVAIDs are properly set.

7.10. Holding:

7.10.1. AFMAN 11-202V3 provides guidance for holding. Most holding fixes are defined by DME limits; however, there are still many holding patterns that require timing. You can slow to holding speed within 3 minutes of the holding fix.

7.10.2. As a technique, begin reducing speed 5 to 10 nm prior to the holding fix (1 to 2 minutes) to ensure entering holding at holding airspeeds (250 to 265 KIAS). Approximately 88 to 90 percent rpm will hold 250 to 265 KIAS in level flight. When correcting for position and/or winds, adjust the displacement on the outbound leg to intercept the holding course inbound.

7.10.3. A technique for a no-wind starting point is 360 divided by DME equals the number of radials displacement desired at the outbound DME limit. For example, a 30 DME outer limit for holding requires about 12 radials of displacement (360 ÷ 30 = 12).

7.11. En Route Descents. En route descents usually provide the quickest and most efficient way to get from the middle or high altitude structure to a landing. The goal of an en route descent is to arrive at a point from which vectors to an instrument final can be followed. Continually update the progress of your en route descent. If in doubt, the conservative choice is to get down a little early. The following techniques will help you determine an appropriate pitch gradient:

7.11.1. Mathematical Gradient. Divide your altitude to lose (in thousands of feet) by the distance to travel (in nm) and then translate the result into degrees of pitch change. For example, you are at a cruising altitude of FL 270, which is 60 nm from where you would like to be when you reach the FAF altitude of 2,000 feet MSL. So, with 25,000 feet to lose in 60 nm, you will need a descent gradient of 417 feet per nm. Because each degree of pitch change results in 100 feet per nm, a nose-low attitude of 4 to 5 degrees will work.

7.11.2. Visualizing the Gradient. Divide your altitude (in thousands of feet) by the distance to travel (in nm) and then superimpose that ratio, using the first 10 degrees of dive gradients on the ADI. Designate the 10-degree, nose-low line on the ADI as the distance to travel. Then visually determine where the altitude-to-lose (in thousands of feet) falls between the level flight line and the 10-degree dive line. For example, using the same scenario as in **paragraph 7.13.1**, you will need to lose 25,000 feet in 60 nm. Designate the 10-degree dive line to be the 60 (nm) and superimpose the 25 (thousands of feet) on the ADI as a visual ratio of altitude over distance. The 5-degree dive line would represent 30 (thousands of feet), so 25 (thousands of feet) would fall about 4 degrees nose-low.

7.11.3. Pitch and Power Techniques. During the initial portion of a high altitude descent—or if the potential for icing exists—consider power settings of at least 80 percent rpm. Also consider engine-operating restrictions when changing power at high altitudes. Headwinds and tailwinds can drastically affect the descent distances resulting from any pitch and power setting combination. **Table 7.1** lists pitch and power setting combinations for various 300 KIAS descent gradients.

Table 7.1. Techniques for Various 300 KIAS En Route Descent Gradients.

I	A	B	C	D
ITEM	**Descent Gradient**	**Pitch Change**	**Power Setting**	**Configuration**
1	200 to 250 feet/nm	2 to 2.5 degrees	20 to 25 percent nozzles	clean
2	300 feet/nm	3 degrees	30 percent nozzles	
3	500 feet/nm	5 degrees	80 percent rpm	

4	700 feet/nm	7 degrees	idle	
5	1,000 feet/nm	10 degrees	80 percent rpm	speed brake
6	1,300 feet/nm	13 degrees	idle	

7.12. TACAN Penetration. The purpose of a TACAN penetration is to descend from an en route altitude to a position from which an approach and landing can be made, using the TACAN as the primary NAVAID. Penetrations are normally flown at 300 KIAS. However, you may fly the penetration at a slower speed—or slow down early—if factors like a relatively short penetration or a low-DME arc make it smarter to do so. If holding is not accomplished, slow to 300 KIAS and set the inbound course prior to the IAF. Consider requesting maneuvering airspace if your inbound heading does not conveniently align you with the initial inbound course. Remember to set the local altimeter setting IAW FIH procedures.

7.13. Precision Approaches:

7.13.1. ILS. The ILS is a precision approach that provides the pilot with final approach course and glidepath information, as follows:

7.13.1.1. Intercepting Final:

7.13.1.1.1. If you are still up near 300 KIAS during the last segment of a penetration (or as you turn onto the base leg), start slowing down. No later than dogleg to final or approximately 10 to 15 nm from touchdown, you should be slowed to 240 to 260 KIAS. NOTE: From 85 to 87 percent will hold these airspeeds.

7.13.1.1.2. Select localizer mode when heading is within 90 degrees of final approach course and have the published front course dialed into the course select window. If a TACAN is located on or near the field, TACAN information will be useful for position orientation and can provide a lead radial for starting the turn to intercept the final course. Use all available references and SA for the turn to final. Do not expect the bank steering bar to guide you perfectly onto final. If you are established on a dogleg to final within 30 degrees of the final course, starting the turn to final as the CDI begins to move should allow a comfortable intercept without overshooting final. Select ILS when stabilized within 15 degrees of final heading and within a one-dot deflection of the CDI.

7.13.1.2. Prior to the FAF. Have the airspeed stabilized below 240 KIAS by about 5 nm prior to the FAF. Configure the aircraft approximately 2 to 5 nm prior to the FAF. Trim and adjust the pitch attitude appropriately on the ADI as the aircraft decelerates. Power settings between 93 and 95 percent rpm will hold final approach airspeed in level flight with gear and full flaps. Use 90 to 91 percent rpm for configurations with 60 percent flaps.

7.13.1.3. Course and Glidepath Control:

7.13.1.3.1. On final, make heading changes of 5 degrees or less for precise course control. Bank angles of 5 degrees or less are sufficient for small, controlled heading changes. To prevent overcorrecting while on the final approach course, make small but positive corrections to centerline deviations. If configured on speed at glide slope intercept, a pitch change corresponding with the glide slope (normally 2.5 to 3.0 degrees) should provide a good initial rate of descent.

7.13.1.3.2. At final approach speeds you are traveling at approximately 2.5 to 3 nm per minute so a 3-degree pitch change will produce a VVI of about 750 to 900 fpm. Adjust the descent rate using pitch changes of 2 degrees (1 bar width) or less to start. Then use changes of about 1 degree for precise glidepath control. Course and glide slope sensitivity increases as you approach decision height; therefore, smaller corrections are required to regain/maintain "on course, on glidepath."

7.13.1.3.3. For an ILS approach using the flight director (normal), a technique is to "hide the dot" of the aircraft symbol under the crosshairs of the flight director steering bars to maintain course or glidepath. Cross-check raw data (glide scope indicator, CDI) and avoid chasing the steering bars. Constantly monitor your altitude in relation to pilot weather category minimums and/or decision height. Monitor your altitude in relation to localizer minimums in case glide slope information becomes unreliable.

7.13.2. PAR. The PAR is a precision approach for which a final approach controller provides verbal course and glidepath information.

7.13.2.1. Intercepting Final. The precision final approach starts when the aircraft is within range of the precision radar and contact is established with the final controller. Normally, this occurs approximately 8 miles from touchdown. Prepare and configure the aircraft the same as for an ILS.

7.13.2.2. Course and Glidepath Control. The same basic techniques for flying an ILS (**paragraph 7.13.1**) can be used to fly a PAR. Follow controller instructions for heading control. Bank angles of 5 degrees or less are sufficient for small, controlled heading changes. If called "below" or "above" glidepath, use pitch corrections of 1 degree on the ADI (1/2 bar width—approximately 300 fpm VVI change) with corresponding 1 percent rpm changes. If called "well below" or "well above" glidepath, use pitch corrections up to 2 degrees (1 bar width—up to 600 fpm VVI change) with corresponding 2 to 3 percent rpm changes. As with the ILS, course and glide slope sensitivity increases as you approach decision height.

7.13.3. Transition to Landing. When approaching the decision height, start glancing outside to pick up the runway or approach lighting. Transition to a composite cross-check as you gain adequate visual references, but be ready to transition back to instruments if weather conditions deteriorate. When the runway is sighted, cross-check visual cues, glidepath lighting, and instruments to ensure a safe landing is possible. If you follow the glidepath of a precision approach down through minimums to a landing, your touchdown will be approximately 2,000 feet down the runway.

7.13.4. Precision Approach Backup. Whenever you are flying a precision approach, be ready to transition to a backup approach. This could be a transition from a PAR to an ILS (or vice versa), or to a nonprecision approach. To make this transition easier, have the approach page and/or approach minimums readily available.

7.14. Nonprecision Approaches:

7.14.1. Intercepting Final. For the base and dogleg turns, use the same techniques described for a precision approach (**paragraph 7.13**) if intercepting a localizer final. If intercepting a TACAN final from an arc 12 to 15 nm from the field, normally a 10-degree lead point provides a comfortable intercept to final. This is indicated by the CDI "coming off the wall." Once established on a dogleg to a TACAN final, approximately 3 to 4 degree CDI deflection should provide a good point to turn to intercept final.

7.14.2. Prior to the FAF. Prepare and configure the aircraft the same as described for a precision approach (**paragraph 7.13**)

7.14.3. Nonprecision Final Descent:

7.14.3.1. The goal of a nonprecision final is to descend to an altitude—below the weather—from which you can make a safe transition to landing. Therefore, it is imperative that you plan and fly the descent to reach the minimum descent altitude (MDA) prior to the visual descent point (VDP).

7.14.3.2. A method for planning the pitch change at the FAF is to calculate the required descent rate. Determine the difference in altitude between the FAF and the MDA and divide by 100. Divide this number by the distance from the FAF to the VDP in miles to get the number of degrees nose-low required to reach the MDA by the VDP. For example, your FAF altitude is 5,000 feet, your MDA is 3,000 feet, and the distance from the FAF to the VDP is 4 nm. Therefore, you have 2,000 feet to lose (dividing by 100 gives you 20). Finally, dividing 20 by 4 nm equals 5. Your optimum descent will be about 5 degree below the level flight reference.

7.14.3.3. At the FAF, or when directed by the controller to "descend to your minimum descent altitude," lower the nose about 4 to 5 degrees on the ADI. Reduce power by approximately 10 percent rpm to maintain final approach airspeed in the descent. Normally, a descent rate of 1,200 to 1,500 fpm will ensure you arrive at the MDA prior to the VDP. Use caution for intermediate step-down restrictions prior to the MDA. As a technique, reduce your descent rate 200 to 300 feet prior to the MDA. Level off above the MDA by an amount appropriate to your proficiency level and readjust power. From 93 to 95 percent rpm will hold final approach airspeed.

7.14.4. Calculating a Visual Descent Point. If published on an approach plate, the VDP is based on the nonprecision approach with the lowest MDA and is normally identified by DME. If the VDP is not published, you must compute your own. The following is a technique for a 3-degree glidepath: height above touchdown divided by 300 equals the descent point from the threshold in nm. Calculate the threshold DME off the profile view. Then convert the nm distance to DME by adding or subtracting the threshold DME. If you are going toward the TACAN, add the distance. If you are going away from the TACAN, subtract the distance. For example, from a height above threshold of 450 feet, 450 divided by 300 equals 1.5. Therefore, the descent point from the threshold would be 1.5 nm. If the threshold DME is calculated to be 0.3 DME for a TACAN on the field, the VDP would be 1.8 DME (1.5 nm plus 0.3 DME).

7.14.5. Transition to Landing. If the runway environment is in sight at the VDP and you are in a safe position to land, a 3-degree nose-down pitch change along with a slight power reduction should set up a transition to landing for the normal landing zone. If you begin the transition late or the runway is sighted after the VDP, you can either accept a slightly longer landing (if the runway length or condition allows) or, if weather and conditions permit, use a momentarily steeper glidepath to re-intercept a 3-degree glidepath. **Warning:** Use extreme caution to avoid excessive sink rates attempting to salvage a late transition to landing. If you are not in a position to execute a safe landing, execute a low approach, missed approach, or climbout.

7.15. Circling. Circling is accomplished at final turn airspeed with 60 percent flaps. During the instrument final approach, descend no lower than circling MDA for the runway to which the instrument approach is flown. Maintain circling airspeed and 60 percent flaps throughout the entire circling maneuver until aligned with the landing runway. Do not descend below MDA until you are in a position to place the aircraft on a normal glidepath to the landing runway. Once aligned with the landing runway in a safe position to land, slow to final approach airspeed and select full flaps, if desired.

7.15.1. Downwind Displacement:

7.15.1.1. For circling maneuvers requiring a downwind leg, proper displacement from the runway is critical (approximately 1 1/2 nm). A low circling altitude will make you feel much wider than you are. Attempting to use sight pictures for the normal overhead pattern may cause an overshooting, high bank angle situation during the turn to final. Do not hesitate to go around if you will need to overbank to prevent an overshoot.

7.15.1.2. Unlike the normal overhead pattern, in which a good part of your turn radius is consumed in the vertical, the circling final turn radius is almost entirely absorbed horizontally. The amount of spacing required to complete the turn to final will vary with airspeed (fuel weight), bank angle, and winds. Poor visibility may require you to stay closer to the runway, but do not use a displacement that requires more than 45 degrees of bank to complete the final turn. As a technique, plan to practice circling in order to remain within published visibility minimums.

7.15.2. Downwind Spacing Techniques. The following techniques assist the transition from the instrument approach portion to arrive at a perch with sufficient spacing to complete the final turn: (**Note:** When using any of these techniques, you must correct for winds.)

7.15.2.1. To Circle 180 Degrees or in the Opposite Direction:

7.15.2.1.1. Turn 45 degrees away from the runway until you have flown “down” the runway about the same distance as your desired displacement. Then turn to parallel prior to the turn to final. For example, for a 10,000 feet runway, hold the 45-degree offset until approaching the end of the runway in forward runway distance covered. This will build about 10,000 feet of spacing.

7.15.2.1.2. A second option is to perform two 90-degree turns using the desired final turn bank angle—the first to turn perpendicular to the runway and the second to turn to parallel. Keeping the runway in sight will be more challenging using this technique.

7.15.2.2. To Circle 270 Degrees. Fly past the runway 15 seconds. Then use the desired final turn bank angle to turn downwind. After passing the landing runway, a second option is to turn downwind, using a bank angle with twice the turn radius of your desired final turn bank angle.

7.15.2.3. To Circle 360 Degrees. Consider delaying the initial turn so you can more easily keep most of the runway environment in sight over your shoulder. If you begin a 360-degree circle at the approach end of the landing runway, you will be belly-up to the runway environment and could lose sight.

7.15.3. Circling Considerations. You must remain vigilant for stall indications and have the discipline to execute a go-around or stall recovery when required. The circling approach presents a potential sink rate problem in the T-38 that may not be accompanied by a stall warning. An overbank during a circling approach creates an insidious descent, which adds to the potential danger.

7.15.4. Unplanned Circling. There may be occasions when you must begin circling from final approach airspeed. For instance, if the runway becomes “wet” during a formation approach, one aircraft may have to circle to land while the other full stops. In these instances, remember to check or reset the flaps to 60 percent and accelerate to final turn airspeed before starting the circle.

7.16. Sidestep:

7.16.1. A sidestep maneuver is a small visual ground track adjustment at the end of a straight-in approach to allow an approach to one runway and a landing on a parallel runway. Where this maneuver is authorized, there may or may not be sidestep procedures or MDAs published on the approach plate. If you are cleared to sidestep where there are no published sidestep MDAs, use circling minimums. Clearance to sidestep will be issued by the tower.

7.16.2. Although sidesteps are not circling maneuvers, one technique is to configure with gear and 60 percent flaps and maintain a minimum of final turn airspeed. In any case, maintain no less than final approach airspeed during the sidestep. You may begin the sidestep maneuver any time after the landing runway is in sight and inside the FAF. Lower full flaps and slow to final approach speed when aligned with the landing runway in a safe position to land.

7.17. Missed Approach:

7.17.1. Perform a missed approach IAW conditions outlined in AFMAN 11-202V3 and flight manual, advance power to MIL, close the speed brakes if open, and raise the nose to the instrument takeoff attitude. With a positive climb established on the altimeter and the VVI reversing, retract the gear and flaps. Accelerate to and maintain 240 to 300 KIAS in a positive climb until reaching missed approach altitude. You may reduce power to 90 to 95 percent rpm to slow the rate of climb, if desired, after attaining 240 KIAS.

7.17.2. If a single-engine missed approach is necessary, apply single-engine go-around boldface. The pitch change will be about 8 degrees when going missed approach from decision height; it will be about 3 to 5 degrees when going missed approach from MDA.

7.17.3. For circling approaches, if the runway environment is not in sight at the missed approach point, execute the verbally issued climbout instructions or published missed approach. If the circling maneuver has been started and the airport environment is visually lost, perform a missed approach for the runway to which the approach was flown IAW AFMAN 11-202V3.

Chapter 8

NAVIGATION

8.1. Introduction. The purpose of navigation is to get from point A to point B. Whether accomplished on a cross-country mission or used to find a target, navigation requires significant preflight planning. Planning a navigation sortie requires you to consider many factors—runway length, barriers, servicing availability, airfield operating hours, etc.—which are taken for granted at the home field.

8.2. Preflight Planning. Prior to departing an off-station mission, familiarize yourself with the strange-field procedures located in applicable FLIP guidance and Section II of the flight manual. Throughout your planning, be very careful to use accurate local or zulu time, as appropriate. Before starting detailed mission planning, verify the following basic requirements:

8.2.1. Ensure your arrival and departure fall inside operating hours for the airfield and the transient alert or servicing fixed base operator (FBO).

8.2.2. Make a preliminary check of the weather, winds, Notice to Airmen (NOTAM), and airfield suitability and restriction report for showstoppers, like runway closures, winds out of limits, or forecasts below minimums.

8.2.3. Call your destination to ensure you can go there, get proper servicing, have a place to stay (if applicable), and depart on schedule. If necessary, obtain a prior permission required number. While you have the destination station on the phone, ask about the landing runway, multiple approach availability, and any unusual procedures or facility changes that are not in the NOTAMs. Variations in off-station pressure altitude, temperature, and runway length could result in TOLD numbers significantly different from typical home field computations. Where the combination of pressure altitude and temperature might be a factor, ensure the TOLD at the out-base will not prohibit your departure.

8.3. Single-Engine Planning. When considering worst-case, single-engine climb capability for instrument flight rules (IFR) departures, the following is one technique to achieve a specific minimum climb gradient:

8.3.1. With at least 2,000 feet of runway available after reaching single-engine takeoff speed (SETOS)—2,000 feet in excess of critical field length—and assuming the proper acceleration attitude is employed, you should be able to attain SETOS + 10.

8.3.2. SETOS + 10 should allow the aircraft to sustain a climb pitch attitude slightly greater than 2 degrees nose high, providing a climb rate slightly higher than 200 feet per nm—the minimum required for a standard IFR departure without a "Trouble-T."

8.4. Planning an IFR Navigation Mission:

8.4.1. Weather and Winds. The weather and winds determine if you can take off; where, how far, and (perhaps) how high you can fly en route; whether you can land at your destination; and if an alternate is required. Prior to the detailed planning, check the following:

8.4.1.1. Departure, en route, destination, and drop-in weather—observation and forecast.

8.4.1.2. Climb and cruise winds, Delta-T, and temperature at altitude for each leg.

8.4.1.3. Surface winds at each base.

8.4.1.4. Possible hazards—icing, thunderstorms, etc.

8.4.2. Routing. Look at the high or low charts to determine the most suitable route of flight. Consider any hazards, no-fly areas, military operations areas (MOAs), standard terminal arrival routes (STAR), and preferred routing. Failure to consider these can cause lengthy delays or changes to your planned flight route.

8.4.3. Distance. Make sure your planned leg lengths provide you with enough fuel to complete training objectives and land with a buffer above minimum fuel. Planning to arrive at your destination with minimum fuel will greatly reduce your options if you experience any delays or—worst case—if you need to divert. Headwinds and tailwinds are often significant factors. Some techniques for leg-length decision-making are as follows:

8.4.3.1. High-altitude, no wind, no drop-in, no pod, one approach to full stop—approximately 700 nm max.

8.4.3.2. High altitude, some wind, no drop-in, pod or clean, one approach—approximately 500 nm.

8.4.3.3. Drop-ins with various approach combinations, pod or clean—approximately 300 nm.

8.4.4. Adjustments for a Cargo Pod:

8.4.4.1. Flying with a pod will cause higher fuel flows due to increased drag. The faster and farther you travel, the greater the fuel effect from a pod.

8.4.4.2. At middle fuel weights, a cargo pod will increase fuel consumption by about 50 to 80 pph/ engine between FL 200 and 300. Depending on climb, descent, approach, and/or distance requirements, a reasonable technique would be to plan to use an additional 100 to 200 pounds for these scenarios.

8.4.4.3. At middle fuel weights, a cargo pod will increase fuel consumption by about 70 to 100 pph/engine between FL 300 and 400. Depending on climb, descent, approach, and/or distance requirements, a reasonable technique would be to plan to use an additional 150 to 250 pounds for these scenarios.

8.4.5. Cruising Altitude. Select cruising altitudes and airspeeds consistent with mission requirements, applicable directives, and safety. The Optimum Cruise-Climb Altitude chart in the flight manual provides the best altitude for initial leveloff based on fuel weight. The best altitude for fuel economy will increase as gross weight decreases. However, due to the need to fly at higher Mach, the susceptibility of the J-85 engines to flameouts and compressor stalls virtually negates any fuel consumption advantage at these higher altitudes.

8.4.6. Destination Review. Note obstacles, airfield layout, barriers, approach lighting, type of visual glidepath guidance, field elevation, runway data, and important frequencies for your destination and any possible en route or destination divert options.

8.5. Planning a VFR Navigation Mission. Maintaining SA will be different on a VFR mission because, although you have fewer distractions from ATC, you also receive less information. This affects the way you plan the mission and the tasks you perform while airborne.

8.5.1. Weather and Winds. VFR conditions do not necessarily mean the absence of clouds. The pilot is responsible for determining that VFR conditions and cloud clearances can be maintained for the entire proposed route of flight.

8.5.2. Map Selection. Choose an operational navigation chart (ONC) or tactical pilotage chart (TPC) based on the desired level of detail. As a technique, use an ONC when flying above 6,000 feet AGL and a TPC when flying below. A Joint Operations Graphic (JOG) chart may be used for detailed route study and preflight planning.

8.5.3. Map Preparation. There is a wealth of information you may choose to put on your VFR map. You may want to highlight emergency airfields, TACAN stations, tower frequencies, etc. Additionally, you need to mark turn points, courses, headings, checkpoints, obstacle elevations, etc., for your route. You will need to plan for a specific Ground Speed (GS) and make tick marks for timing. You may run either a continuous clock or individual leg times. Other handy information would include Class B, C, and D airspace boundaries and frequencies, conflicting airways, air route traffic control center (ARTCC) sector frequencies, and planned fuels.

8.5.4. Routing. You must do enough research on special use airspace, victor airways, and Class B, C, and D airspace to avoid them. When selecting turn points, use very prominent features that you could still navigate by despite potential low scattered clouds.

8.5.5. Distance. When determining the length of a VFR leg, consider the altitude you plan to fly and the winds at altitude. VFR legs between 250 and 350 nm work well, with or without a travel pod. This will allow you fuel for several overhead patterns or the option of coordinating for practice instrument approaches after your VFR arrival. As a guide, do not plan a VFR leg greater than 400 nm.

8.5.6. AF Form 70, *Pilot's Flight Plan and Flight Log*, for VFR Missions. If all pertinent information—including fuel requirements—is on your VFR map, an AF Form 70 is not required for the portion of the VFR mission covered by the map. Measure headings and distances directly from the VFR map. Compute your GS by using the forecast winds, and use GS to determine the total time en route and fuel required. As a technique, include on your map all information you will need for the VFR arrival (frequencies, pattern altitudes, etc.).

8.5.7. DD Form 1801, *DoD International Flight Plan* for VFR Missions. The Route of Flight block on DD Form 1801 should include enough information to allow search and rescue operations to trace your flightpath. You may use any of the following: names of cities and towns, prominent landmarks or water bodies, TACAN radial and DME, latitude and longitude, and VFR reporting points.

8.6. Preflight Ground Operations:

8.6.1. Logistics. As many pilots have discovered over the years, being without necessary equipment, paperwork, or supplies can seriously degrade a cross-country experience. Maintenance should help you launch with tires and aircraft inspections that will last for the duration of the cross-country flight. In addition to personal baggage, before launching from any home station or out-base, consider including the following "don't leave without it" items: (**Note:** These are not all-inclusive.)

8.6.1.1. Required low and high en route charts.

8.6.1.2. Required approach plates and STARs.

8.6.1.3. Low-level and VFR maps.

8.6.1.4. Instrument hood.

8.6.1.5. Aircraft forms (AFTO Form 781-series).

8.6.1.6. Civilian and military fuel cards.

8.6.1.7. Fuel receipts.

8.6.1.8. Intake and exhaust covers.

8.6.1.9. AOA vane lock.

8.6.1.10. Grounding wire.

8.6.1.11. Flashlights and clear visors.

8.6.1.12. Low-level timers and/or stopwatches.

8.6.2. Transient Alert or FBO Ground Crews. Ensure transient alert FBO personnel are familiar with starting and poststart procedures. Become familiar with how to operate the manual diverter valve in case you need to explain its operation.

8.6.3. Getting Clearance. Prior to engine start, determine the status of your clearance with clearance delivery or ground control. If you anticipate any delay, consider postponing engine start until receiving your clearance. Be sure you can comply with any differences between your received clearance and your planned route of flight. For VFR flights, local directives and good sense may require you to ask for a squawk for flight following.

8.6.4. Cockpit Organization. Cockpit organization is very important. Arrange your publications so you can get to everything without cluttering up the cockpit. Arrange publications in the map case in the order you will be using them. More than for other types of missions, you will need a place to write on in short notice, so put your cards, AF Forms 70 and knee board near your writing hand. Do not have any publications loose with the canopy open.

8.7. Departure:

8.7.1. Departing from a Nonmilitary Field. When departing from a nonmilitary field, you must contact the nearest flight service station (FSS) or coordinate through the tower with your actual departure time so you do not arrive unannounced at your destination.

8.7.2. Departing VFR. After you are cleared for takeoff, squawk "1200" and remain on tower frequency until you depart their airspace. If departing an airfield that lies within Class B or C airspace, you must contact departure control after takeoff. Until you exit ATC airspace, comply with any instructions (headings, altitudes, squawks, etc.) issued by the ATC. If you depart from a civilian field, you will need to contact the nearest FSS on 255.4 to activate your flight plan. You are responsible for maintaining VFR cloud clearances. Once you leave tower frequency, you have two options:

8.7.2.1. VFR Option Number 1. Contact ATC for flight following. Squawk the assigned code (if other than 1200), and fly requested altitudes if weather allows. ATC will provide you with traffic advisories as time permits, but you must aggressively clear at all times. You will be passed from controller to controller as you proceed along your route.

8.7.2.2. VFR Option Number 2. You may remain on 255.4 (the FSS frequency) for the entire route of flight. If you choose this option, contact subsequent FSSs as your sortie progresses. Remember to get the local altimeter at least every 100 nm.

8.8. En Route IFR and VFR:

8.8.1. Airspeed. When flying at high altitude, maintain an IMN appropriate for the engine envelope. The flight manual checklist's Engine Compressor Stall/Flameout Susceptibility chart specifies a minimum IMN for a given altitude and temperature. Anything that induces turbulence or interrupts airflow, such as bank or yaw and abrupt throttle movement, can increase susceptibility to a flameout or compressor stall.

8.8.2. Ground Speed (GS) Check. Once stabilized at your planned cruise airspeed, do a GS check to compare your actual to planned GSs and determine the effect of the actual winds. You can also request a GS readout from the ARTCC controller.

8.8.3. Way Point Checks. As you pass your planned way points, compare your actual fuel and flight time to those you planned.

8.8.4. Flight Plan and Route of Flight Adjustments. Unusual ground delays, low altitude step-up restrictions, and/or unforecast headwind velocity could place you in a potentially fuel-deficient situation. Apply any significant differences between planned GS and/or fuel remaining to the remaining route of flight and modify your flight plan, if necessary. In a worst-case situation, you may have to divert to a suitable airfield short of your destination.

8.8.5. Lead Points:

8.8.5.1. When flying on published jet routes or airways, remaining within the protected airspace requires the use of good lead points during turns to new courses. The most mathematically unusual situation occurs when making a significant turn over a TACAN way point because the cone of confusion will begin at a rather large slant-range DME. The technique (Mach 2) will give you the correct lead point in nm, but triangle hypotenuse math is required to turn it into a useable, close-to-the-station DME.

8.8.5.2. The following is an easier technique to calculate no-wind DME lead points for 30 degrees of bank turns at normal cruising airspeeds or altitudes: lead point equals 1 nm for each 30 degrees of turn plus altitude in nm above the station. For example, approaching a TACAN at FL 360, you would be turning from a 270-degree inbound course to a 330-degree outbound course. For this 60-degree turn, you would take 2 nm (1 nm for every 30 degree of turn) and add 6 (your altitude in nm). Your lead point would be approximately 8 DME.

8.8.6. Radio Frequencies. Maintain a record of assigned frequencies in case you are sent to a bad frequency and must recontact the last controller.

8.8.7. Positional Awareness. Because a radio or NAVAID failure can occur at anytime, maintain constant positional awareness through the use of NAVAIDs, map-reading, and dead reckoning (DR).

8.8.8. Weather and Winds. Check the weather far enough out (80 to 120 nm) so you can be thoroughly prepared for your arrival as well as any unexpected changes or diverts. In addition to checking destination or drop-in weather, you may want to check the weather at your planned alternate. If you have time and/or are queried by a pilot to metro service (PMSV) forecaster, make a pilot report (PIREP). (The format is in the FIH.) To obtain destination, drop-in, or alternate weather and winds en route, there are several options:

8.8.8.1. Automated Terminal Information Service (ATIS). This is the easiest and quickest option, but not always a reliable one. Some ATIS messages are less complete and less frequently updated than others, especially on weekends. Listen for the time group to see how old the information is and make decisions accordingly. Note the letter identifier for your check-in with approach control.

8.8.8.2. PMSV. The worse the weather, the more you will prefer to use PMSV if it is available. The information provided should be current. You can talk to a forecaster, if needed, and ask real-time questions about trends, actual thunderstorm activity, divert options, etc.

8.8.8.3. Approach or Tower. Consider this option if (1) you are unable to receive ATIS or contact PMSV or (2) you are arriving at a civilian field with no ATIS or VHF-only ATIS. Use discretion on what could be a busy frequency. A quick request for the landing runway and current observation will give you enough information to make initial decisions.

8.8.8.4. Supervisor of Flying (SOF). At military fields, the SOF on duty can be an excellent option in lieu of ATIS or PMSV. In fact, in certain circumstances (timing of exercises, ceremonial events, flybys, etc.), talking to the SOF may be highly preferred.

8.8.8.5. FSS. Contact an FSS on frequency 255.4, using the call sign “radio” (for example, “Greenwood radio”). FSSs contains reliable, full-service teams, complete with PIREP information (when it has been provided).

8.8.9. VFR Altitudes En Route. Fly VFR altitudes according to FLIP. Assuming you have the weather and have cleared carefully, you may change your altitude any time during the flight. You do not need permission to alter your altitude, but you should inform the controlling agency of your intentions if you are getting flight following service. In formation, all flight members should be at an appropriate VFR altitude.

8.8.10. Encountering Unexpected Weather While VFR En Route. If you encounter unexpected weather, you have the following three options:

8.8.10.1. Alter Route of Flight and Continue. You may alter your route and/or altitude to avoid unexpected weather, but you must continue to maintain the required VFR cloud clearance and visibility requirements. Ensure your fuel allows any deviations from the plan. Inform FSS personnel of any major route changes and pass them a PIREP describing the unexpected weather.

8.8.10.2. Return to Base of Origin or Divert. If you have not proceeded far from your departure field, turning around and returning there may be the best option. If you are significantly down track on the route, proceeding to an alternate airfield may be preferred. In either case, maintain VFR conditions and ensure sufficient fuel exists. Inform FSS personnel of route or destination changes, give them a PIREP, and obtain the NOTAMs for your new destination.

8.8.10.3. Pick Up an IFR Clearance. Contact a FSS or controlling agency to file an IFR clearance. (ARTCC frequencies can be found on FLIP low altitude en route charts.) Until your IFR clearance is activated, you must maintain VFR conditions. Picking up an IFR clearance while airborne is really quite simple, but it requires some preparation. You will be required to provide the same type information that you would use on a DD Form 1801. Use the sequence on the back cover of the IFR en route supplement to help you organize and provide the right information.

8.9. VFR Lost Procedures. First, use every possible resource to regain positional awareness. Attempt to determine your position by plotting a radial and DME from a known TACAN onto your VFR map. If the DME is inoperative, attempt to identify your location by cross-tuning radials from two different TACAN stations. If, after using every possible resource for positional awareness you still cannot determine your position, follow the procedures below:

8.9.1. Climb—Conserve—Confess:

8.9.1.1. Climb. For fuel conservation, climb to the highest possible altitude below FL 180 where you can maintain VFR.

8.9.1.2. Conserve. Establish the maximum endurance airspeed for your fuel weight (230 KIAS + total fuel).

8.9.1.3. Confess:

8.9.1.3.1. Call for help. Admitting you are lost and getting help is far better than delaying until you are low on fuel. Start with appropriate ARTCC and approach frequencies (try several if necessary), but do not hesitate to use the guard frequency. For guard calls, preface the call with "mayday, mayday, mayday," give your call sign, and request help from any agency hearing the transmission.

8.9.1.3.2. A number of controlling agencies will probably answer your distress call. Select one and direct the rest to remain silent. Select Emergency on the identification, friend or foe/selective identification feature (IFF/SIF) master control knob or set code 7700 in Mode 3/A. Positioning the master control knob to Emergency disables the IFF/SIF IDENT feature. The controlling agency can give you heading and distance information to the nearest suitable airfield, your home field, or your destination.

8.9.2. Check the Compass. Before accepting radar vectors or proceeding direct to a TACAN station, ensure your HSI is operating properly and compare it to the standby magnetic compass. If they do not agree, use the magnetic compass and consider slaving the HSI.

8.9.3. Without Radio Contact. Attempt to pick out a prominent landmark on the ground—a body of water, a town, a large airport, or a railroad crossing are all good landmarks. Try to orient your map with the selected landmark. If you cannot locate the landmark on your map, do not wander aimlessly. Fly a definite heading until you can identify a good landmark.

8.10. IFR Arrival:

8.10.1. Descent From High Altitude. Consider preheating the canopies with the canopy defog because descents into warmer, humid air may cause the canopies to fog up.

8.10.2. Clearances. There are at least three clearances requiring careful attention during any arrival:

8.10.2.1. IAF or Beginning En Route Descent. Before arriving at an IAF or holding fix, or before beginning an en route descent, know your clearances and any restrictions. These often include holding instructions, approach clearance, clearance to use maneuvering airspace, expect further clearance times, en route descent instructions, etc. This is especially important when on an en route descent in the event of radio failure.

8.10.2.2. Missed Approach or Climbout. Before the FAF, coordinate climbout, missed approach, alternate missed approach, and/or departure instructions, as appropriate. Write them down!

8.10.2.3. Landing. Passing the FAF, ensure you know your landing clearances and restrictions; for example, proper runway, low approach, land, touch-and-go, option, sidestep, circling, restricted low approach, etc.

8.11. VFR Arrival on an IFR Flight Plan. If flying in Class A airspace or in IMC, coordinate with the en route ARTCC for a descent to VFR conditions below the Class A. Cancel IFR when able to maintain VFR and navigate to the airfield, using a VFR map and NAVAIDs. Clear visually and over the radios. Coordinate with ATC to proceed VFR-to-initial or to a visual straight-in. When practical, remain on ATC frequency for traffic advisories.

8.12. VFR Arrival at an Unfamiliar Field:

8.12.1. Coordination. Know the classes of airspace affecting your VFR arrival. These may be obtained from FLIP AP/1 or the IFR en route supplement. You must abide by these airspace rules even when VFR. Approximately 40 nm out, check the weather and current runway (ATIS, if available). Approximately 30 nm out, contact ATC and request the VFR arrival.

8.12.2. VFR to Initial. Plan on a 3 to 5-mile initial. To maintain positional awareness approaching airports with several offset or crossing runways, keep SA on your inbound bearing to the field and your current heading, comparing them to an airport diagram. The IFR en route supplement normally indicates the pattern altitude and direction of break, but listen carefully for modified instructions and other guidance like wake turbulence, runways, type landing, etc. Clear for other aircraft or helicopters, stay aware of wake turbulence separation, and be vigilant for degraded aircraft performance at high-density altitudes.

8.12.3. Visual Illusions. Use caution when landing on unfamiliar runways. Start with a careful study of the airport diagram and the IFR en route supplement so you know what to expect. Plan for how you might adapt to a runway without an overrun or one with a displaced threshold. Remember that a wider runway may contribute to a high flare and a long or dropped-in landing, while a narrower runway may lead to an incomplete flare and early landing. Usually, a wider runway will have side stripe markings approximately 140 to 150 feet wide to help with depth perception. Use all available references to determine your height above the runway.

8.13. Off-Station, Post-Flight Ground Operations:

8.13.1. Canopy Management or FOD. With so many items potentially cluttering the cockpit during a cross-country mission, you may want to leave the canopies closed until engine shutdown. In any case, double-check to ensure all loose items are accounted for and secure before opening the canopies.

8.13.2. Taxiing on a Strange Field. Although you can request progressive taxi from the ground or tower controller, you can maintain higher SA by referencing the airport diagram and signs posted along your taxi route. With a little prior study, you can often anticipate your taxi route and parking area. Many civilian and military transient operations use a “follow me” vehicle as well.

8.13.3. Closing Flight Plans. Normally, there is no need to close an IFR flight plan with FSS. The tower should do this for you at a military or civilian field. However, because some civilian fields are not as reliable as others in always closing your IFR flight plan, it is usually wise to verify with the FSS or tower that it has been closed. Remember, IAW AFMAN 11-202V3 you are responsible for closing a VFR flight plan with FSS.

8.13.4. After Engine Shutdown. Refer to the checklist and other appropriate items in your in-flight guide. Conduct a thorough post-flight inspection of the aircraft and ensure transient alert personnel are familiar with the T-38's servicing requirements. Also, ensure they properly secure, pin, and ground the aircraft. Ensure you are familiar with alternate fuel procedures, if applicable. Complete all required paperwork. When possible, give transient alert a phone number where you can be reached, even if it is the billeting number. You are ultimately responsible for your aircraft until it returns to the home station.

8.13.5. Stopovers. As a technique, the following acronym—WANTS—will help you remember what to accomplish at a stopover location:

8.13.5.1. **W** eather, winds, temperatures, bird status.

8.13.5.2. **A** ctivate flight plan or **A**lternates and emergency fields.

8.13.5.3. **N** OTAMs.

8.13.5.4. **T** OLD.

8.13.5.5. **S** ID or departure instructions. Call the **S**UP, **S**OF, or command post.

Chapter 9

LOW-LEVEL NAVIGATION

Section 9A—Purpose

9.1. Overview. The purpose of low-level navigation is to fly a preplanned ground track to a designated target so as to arrive at a designated time over target (TOT). Flying high-performance jet aircraft on low-level missions puts you close to the ground at high speed. Your close proximity to the ground increases the risk to flying. In addition to the ground, other threats include aircraft, birds, and obstacles. Therefore, your margin for error and your time to react are greatly reduced. The intent of low-level training in the T-38 is to provide the basic foundation from which to build as you transition into different mission design series. Each low level will be broken down into mission planning, briefing, and flying phases.

Section 9B—Mission Planning

9.2. Overview. The first step in preparing for the mission is becoming completely familiar with the route requirements and any associated restrictions. Consider referencing a sectional chart to determine national airspace restrictions. Applicable publications include FLIP GP, AP/1B, the Chart Update Manual (CHUM), and command and local guidance.

9.3. Military Training Route (MTR) Selection:

9.3.1. In the United States, military low-level training is conducted in Federal Aviation Administration (FAA) designated airspace as outlined in FAA Order JO 7610.4V, *Special Operations-*Non-FAA Employees* and FAA Order JO 7110.67K, *Air TrafficManagement Security Services for Special Operations *Non-FAA Employees*. The primary reference for MTR selection will be via FLIP AP/1B. The slow routes (SR) are not used by T-38s due to airspeed restrictions.

9.3.2. When selecting a route, identify your departure and recovery bases and find a route nearby. In many cases, the instrument routes (IR) and visual routes (VR) described in FLIP AP/1B are too long to successfully fly from the primary entry to the primary exit. Therefore, an alternate entry or exit (or both) may have to be used. Route selection should be made so navigation to the desired entry, flying the route, and recovery to the desired destination can be completed with the limited fuel carried by the T-38.

9.3.3. For initial fuel planning, approximately 45 pounds per minute at 360 GS (6 nm per minute) works while on the low level. (For example, in 40 minutes, 240 nm of low level will use approximately 1,800 pounds of fuel.) The longer the planned low level, the less fuel remaining for navigation to and from the route; and therefore, the closer the route needs to be to the planned departure or recovery base. Additionally, ensure the en route and on-route weather will allow you to fly the selected low level. Refer to AP/1B for VR weather minimums and AFMAN 11-2T-38, Volume 3, for IR weather minimums.

9.4. Map Preparation. On low-level missions, each pilot must carry a current map of the route. Refer to map preparation requirements in AFMAN 11-2T-38, Volume 3, and any command and local supplements.

9.4.1. Map Selection. For sufficient detail and quality of terrain features, a published TPC (1:500,000 scale) or a chart generated from flight planning software should be used. With greater detail, JOGs can be excellent for low-level missions. However, they may be cumbersome because of their size. For low-level routes flown with TPCs, you may want to carry JOG sections of the turn points and target areas. You may also find JOGs especially useful for detailed route study during preflight planning.

9.4.2. MTR Corridor:

9.4.2.1. Draw the MTR corridor from the planned entry point to the planned exit point, using the latitude-longitude of the published way points and designated route corridor lateral displacements. Additionally, make annotations for the vertical limits of the route segments. These may be incorporated into the course arrow blocks when drawn onto the map. Update the chart with the latest information from the CHUM to include all the area within the route corridor and any significant obstacles outside the route corridor that could be a hazard to the flight. This step is imperative for flight safety and may be completed using approved flight planning software.

9.4.2.2. Study the route thoroughly to gain an initial feel for all obstacles and terrain features at or above planned flight altitude. Highlight any obstacles or high-terrain features that may be a factor along your route of flight, using appropriate, thin-line “bubbles.” One technique is to use 2to 3-mile bubbles to mark decision-making points for those obstacles not acquired visually.

9.4.2.3. Lastly, use the appropriate sectional map to determine all crossing MTRs.

9.4.3. Route Abort Planning. Compute the route abort altitude (RAA) for the entire route or area at a minimum of 1,000 feet separation from the highest obstacle or terrain feature (rounded to the next highest 100 feet) within the lateral limits of the route or training area, but in no case less than 5 nm either side of planned course (black line). Route abort frequencies can be obtained from the “postage stamps” on FLIP low charts. Highlight the map with emergency or alternate airfield locations and information such as TACAN channels and tower and approach frequencies.

9.5. Route Development. As a minimum, you will need a route entry point, a high-confidence “hack” point for your clock or timer, recognizable turn points, a clearly discernible initial point (IP), and an appropriate target. The best features for turn points are usually natural because these features change very little over time. You may also use manmade features such as bridges, road intersections, and towers. Choose points for their uniqueness, vertical development, funneling features, and surrounding terrain. Avoid using features that may be hidden by high terrain or trees.

9.5.1. Route Entry and Hack Point. Note that your route entry point must be within the route corridor and should correspond with a published entry point (or alternate). A TACAN radial or DME is a good way to confirm an entry point. The hack point can either be the FLIP-designated route entry point or down track following an acceleration corridor or route entry corridor. Choose an easily discernible hack point because the first key to good DR is to start from a known point. Do not plan a hack point that requires an immediate turn to remain on course. The hack point is a high-task portion of the sortie. Therefore, minimize maneuvering to ensure a safe and effective route entry.

9.5.2. Turn Points. Draw thin-line circles around turn points to prevent obscuring the surrounding details. When choosing turn points, consider the turn radius of the T-38 at your planned GS and the type of turn you will be using. Avoid choosing points so close to the corridor edge that your planned turn radius will not allow you to stay within the corridor. If the appropriate circles are available, use a tactical plotter to plot the turn radius based on starting turns right over the turn points. There are two common choices for low-level turns. One choice is a hard (4 G) turn, similar to the kind used in tactical formation. Use approximately 1 nm for a turn radius for these hard turns. A second choice is a 55 to 60-degree bank, 2 G turn. This turn matches the 55-degree bank turn radius circle on most tactical plotters.

9.5.3. Initial Point (IP) and Target. Choose an IP located about 1 to 3 minutes prior to the target. An IP should be an easily identifiable point used to fine-tune the navigation and increase the probability of target acquisition. Minimize the heading change (up to 30 degrees) at the IP in order to increase the accuracy of the IP-to-target leg. At the IP, you will normally continue the running time to the target. If your running time to the target is off, rehacking at the IP may help you identify the target. Choosing a clearly discernable target with prominent lead-in features will increase your chance of properly identifying and overflying the objective.

9.5.4. Course Lines and Timing Marks. When drawing course lines between turn points, use thin lines and be sure to account for the turn radius corresponding to your planned GS and bank angle. Select a GS that easily converts to miles-per-minute, but still allows room for required airspeed corrections. A GS of 360 knots works well at relatively low MSL altitudes to allow an easy conversion to 6 miles per minute. It also permits enough airspeed correction capability to maintain above a minimum of 300 KIAS and below a maximum of 420 KIAS (450 KIAS for the T-38 IFF). The IP-to-target run may be planned at a different airspeed. Place tic marks along the route to represent the timing intervals. A 1or 2-minute interval is sufficient.

9.5.5. Headings and Drift Corrections. Plot the no-wind headings for each segment of your route and ensure proper application of the magnetic variation. Low-level winds are generally mild, not exceeding 15 to 20 knots. However, they can be quite significant under certain weather conditions, such as wind shears, frontal passage, or thunderstorms. The drift angle and IAS will change on each leg of the route, depending on the aircraft's heading in relation to the relative wind. You must apply drift correction to maintain course and adjust airspeed to keep GS constant. Compute and post wind-corrected headings (or ± correction factor) for each leg of your route. If your planned GS is 6 miles per minute, a simple technique is to apply l degree of drift correction for every 6 knots of crosswind.

9.5.6. IAS. Use the forecast temperature, the pressure altitude, and low-level winds to compute wind-corrected IASs for each leg at the planned GS. To keep GS constant, IAS should be decreased for a tailwind and increased for a headwind. To simplify airspeed computations, assume there is a one-to-one relationship for increases and decreases in airspeed between calibrated airspeed and GS.

9.5.7. Course Arrow Blocks. The course arrow block is a symbol used to efficiently present the information needed to help you fly the low level. The course arrow block should include the information pertinent to navigation along the applicable leg of the route which, as a minimum, would include heading, airspeed, and leg time. This emphasizes the core requirements for good DR of time, distance, and heading. Additional information can be added per individual desires, but too much information could become distracting and divert your attention inside the cockpit when it needs to be outside.

9.5.8. Fuel Planning. Compute a planned fuel at designated points along the route. Refer to the flight manual charts for the required fuel flow. As a technique, a fuel flow of 1,350 pph/engine will normally maintain 350 KIAS. Additionally, compute a continuation fuel for designated points along the route. Continuation fuel is the minimum required to complete the route at planned speeds or altitudes and RTB with the minimum required fuel reserves. Finally, compute and annotate the bingo fuel for RTB by the most practical means from the most distant point on the route. Consider factors such as cloud ceilings, winds, freezing level, MOAs, VFR hemispheric altitudes, forecast icing, and minimum required fuel reserves.

9.5.9. Restrictions. Highlight and plan to remain clear of any noise-sensitive areas or airfields specifically listed in FLIP AP/1B and local directives.

9.6. Routing To and From the Low-Level Route. Good route study includes more than the low-level route between the entry point and exit point. Pilots must have a solid understanding of how to get to and return from the MTR. According to FLIP AP/1B, flight to and from IR or VR routes should normally be conducted on an IFR flight plan. You should normally include the planned route of flight to and from the MTR on your map to include headings, airspeeds, and times. Ensure your planning includes both no-earlier-than and a no-later-than takeoff times, which will allow you to enter your low level on time and also permit completion with the amount of fuel on board.

9.7. Scheduling. Schedule the low-level route for your desired entry time with the scheduling activity as designated in FLIP AP/1B. In instances where there is no published entry timing tolerance window or local guidance, coordinate an acceptable entry window with the scheduling activity. This becomes important in helping deconflict the route, especially with multiple usage by dissimilar aircraft. It becomes most important on VR routes where ATC is not responsible for the separation of aircraft. NOTE: On routes you are not familiar with or do not routinely fly, it may be beneficial to do this scheduling step early in the planning process to verify there is no unpublished or short-term restriction to prevent you from flying the route.

9.8. Filing. File for your low-level sortie on a DD Form 175, *Military Flight Plan*, following the procedures outlined in FLIP GP. Annotate your low-level entry and exit times in the Remarks section of the DD Form 1801.

9.9. Map Study:

9.9.1. Detailed map study is essential after planning the route. You must prepare so as to minimize your heads-down time during the low level. Noting the general shape of the land and its most significant features is a good starting point. A JOG (1:250,000 scale) may initially help you interpret data on the TPC (1:500,000 scale).

9.9.2. Try to visualize the key points along the route and general features around them. Funneling features, such as converging ridge lines, rivers, and roads, are especially helpful in locating selected turn points. Use large, prominent features to funnel your eyes to the smaller features leading to your points. (Navigate from large to small.) To make course adjustments significantly more obvious on the route, note the distance you expect to be left or right of features, such as towers, bridges, dams, river bends, etc.

9.9.3. For mid-leg reference points, it is also critical to note the expected time along the route that point becomes significant. This chronological understanding of key navigation points will help reinforce clock-to-map-to-ground pilotage and minimize unnecessary deviations from basic DR. It is also a good technique to memorize the sequence of events, features, and actions required during the IP-to-target run. Thorough map study will significantly aid in a smooth, efficient brief of the sortie.

9.9.4. Much of your map study will be accomplished by preparing your map and drawing your route. This step becomes especially important if you are planning to fly a low level with a map you did not prepare.

Section 9C—Briefing

9.10. Overview. The overall effectiveness of the sortie can be dramatically affected by how thoroughly and completely the sortie is briefed. Refer to the Avian Hazard Advisory System Web site (**http://www.usahas.com**) prior to the brief and address any significant bird threats.

9.11. Route Briefing:

9.11.1. A commonly accepted technique is to structure your brief so the last thing you cover is the low-level routing itself. This will emphasize the important points and keep them fresh in everyone's mind.

9.11.2. The briefing should include how you plan to identify and enter the route. As you progress down the route, highlight the critical action points—where you expect to see good track or timing correction points, when to climb or laterally avoid unseen towers or airfields, how high to climb and remain in the route structure, where potential aircraft threats or crossing routes are expected, your specific exit procedures, and what altitude and frequency you can use in IMC.

9.11.3. Emphasizing specific action points along the route will set the groundwork for good DR (clock to map to ground). A thorough understanding of what to look for (and when) will also help minimize the airborne tendency to spend too much time map-reading or trying to make what you see on the ground fit what you see on the map.

9.12. Emergency or Contingency Briefing. Emergency or contingency options pose their own unique challenges in the low-level environment. Diverting your attention into the cockpit for too long may have catastrophic consequences. In all abnormal situations on the low level, your first reaction should be climb to cope. You can cover emergency or contingency by leg as you brief or you can cover it as a separate topic from the route brief. Remember, not all emergencies can be covered, but the more thoroughly you brief initial actions—how high (top of the block or RAA), which way (left or right), which recovery field (primary or emergency), who to talk to, and what frequency—the more likely you are to successfully recover the aircraft during a contingency situation.

Section 9D—Flying the Route

9.13. Departure and Route Entry:

9.13.1. Before departing for the jet, referencing the Avian Hazard Advisory System one more time may provide real-time radar tracking of bird activity. Prior to takeoff, ensure you have a good heading system. Maintain positional awareness en route to the entry point, using all available visual references and NAVAIDs. If you are unable to make your originally scheduled entry time, coordinate for a new time or fly an alternate mission.

9.13.2. Make an entry call with the appropriate controlling agencies or FSS. Once inside the route structure, accelerate to the planned airspeed. Identify the entry or hack point as early as possible and maneuver the aircraft to overfly the entry point on the correct heading and at the correct airspeed.

9.13.3. Being at the correct airspeed and heading is more important than immediately descending to your planned route altitude. Start your clock as you pass over the hack point because positive identification of your hack point is of the utmost importance.

9.14. Route Basics:

9.14.1. **Priorities.** Avoiding the terrain and anything attached to it is the most critical task during low-level flying. Your first priority will never change—keep your aircraft under positive control and at an appropriate altitude. Keep your primary attention out of the cockpit and do not become fixated on the map or anything else inside the cockpit. Comply with the command-prescribed minimum altitudes, but do not exceed any crewmember’s comfort level in an attempt to fly at that altitude. An unfamiliar route, poor visibility, mountainous terrain, or other factors may require a higher altitude to maintain a reasonable level of comfort.

9.14.2. Map-Reading and Pilotage. Map-reading is the determination of aircraft position by matching symbols on a map with corresponding terrain features or manmade objects on the ground. Aircraft position should be determined and navigational errors detected or corrected by using a clock-to-map-to-ground cross-check. Thorough route preparation, study, and briefing will have already determined the best “clock” points to make track or time verifications and adjustments. While flying the route, you must first stay aware of the time elapsed, remembering to consider any timing error from the last leg and how it might affect your current position. Then reference the map for where that should put you (interpolating between tick marks, as necessary) and match the map with what you see outside.

9.14.3. Flying the Plan. Flying well-planned, accurate headings and airspeeds on each leg will get you close to your selected points. Trust your plan and rely on good DR. Arriving over checkpoints at anticipated times confirms the accuracy of DR and indicates reliability of preplanned headings, winds, and GSs. If a prominent landmark is not available as a reference at a turn point, rely on DR and turn on time. Conditions such as a cloud cover or extensive areas of featureless land or water may make map-reading extremely difficult. By learning to apply the basic principles of DR (time, distance, and heading), you will minimize the loss of SA.

9.15. Altitude:

9.15.1. Judging Altitude. Low-level training in the T-38 is done without a radar altimeter. Therefore, a critical (and valuable) skill to master is the art of visually assessing your height above the ground. Altitude references include the horizon, altimeter, and ground objects.

9.15.2. Terrain and the Horizon. Altitude awareness and the ability to maintain a desired altitude are relatively easy over terrain where large ground objects are present. However, most pilots have a tendency to descend lower than desired over flat, even terrain. This is especially true if there are few significant manmade or natural objects to reference for altitude, such as in high desert plateau country. Very flat terrain, snow, or calm water are exceedingly and insidiously dangerous due to the lack of reliable depth perception. Flat, up-sloping terrain is even more dangerous because of the insidious change in elevation as you fly into the gentle upslope. Flying across sloping terrain may provide a false horizon that can slowly draw you off course as you dip a wing to maintain level flight.

9.15.3. Altimeter. Occasionally cross-check the altimeter against the known elevation of towers, lakes, airfields, or peaks. Use that "snapshot" outside to calibrate your eyes and refine your ability to judge your height visually.

9.15.4. Terrain and Ridge Crossings. Flying low level in an environment with rapidly changing terrain is demanding and requires constant positional awareness and SA. Realize that terrain can easily hide checkpoints or turn points. Fly upwind of ridges when possible and be alert for areas of turbulence on the downwind side of large terrain features. When planning to cross steep peaks or ridges, consider calculating a start-climb point. Begin the climb early enough to arrive at your minimum AGL altitude prior to the terrain feature or obstacle. To maintain your desired terrain clearance when crossing ridges, either bunt or roll, but do not exceed the limits established in AFMAN 11-2T-38, Volume 3.

9.15.5. Obstacle Avoidance. If lead is unable to visually acquire or ensure lateral separation from known vertical obstructions that are a factor to the route of flight, he or she will direct a climb no later than 3 nm prior to the obstacle to ensure vertical separation by 2 nm from the obstacle.

9.16. Heading Control. Make every attempt to cross your chosen route start point—usually the hack point—on the precomputed, wind-corrected heading. While on the route, "fly the plan." When it is clear a heading correction is required, consider the following techniques:

9.16.1. Drift Analysis in Flight. In flight, use pilotage to compare your plan against what is actually happening. If the forecast winds were accurate, little or no change should be required to maintain the proper ground track. However, if the winds were inaccurate, adjustments will be required. Look for cues (for example, blowing smoke or an unexpected crab to maintain ground track) to verify actual wind direction. Then adjust accordingly.

9.16.2. Heading Errors. Heading errors can be caused by extracting the wrong heading from the map during preflight planning, applying the magnetic variation incorrectly, or not maintaining the appropriate preplanned magnetic heading in flight. Flying your planned heading is essential. At 360 GS, a 10-degree heading error will take you 2 NM off your course in just 2 minutes.

9.16.3. Visual Track Correction. The simplest and most reassuring way to make a low-level track correction is to positively identify a ground reference and visually reposition your aircraft in proper relation to it. As soon as you determine you are off course, immediately attempt to position yourself back on or near track and assume the correct heading again. Be aware that this technique can add to your leg time.

9.16.4. Heading Correction. If you have passed the reference point used to determine your position and you know the distance displaced from the correct ground track, you can correct your error by using the 60-to-1 rule to correct ground track. At 360 knots GS, a 10-degree heading correction held for 1 minute will correct you back toward course 1 NM.

9.16.5. Take Advantage of Unmistakable References. Continue to adjust the ground track and IAS until aircraft position and elapsed time position coincide (especially at predetermined, unmistakable points). When you identify a landmark that shows you are off track, make small corrections immediately to avoid having to make large heading changes later as you get closer to the landmark.

9.17. Timing:

9.17.1. General. The TOT can be based off a chronometer hack or a real-time TOT. If you are using a real-time TOT, back your times up to takeoff so you know the latest possible takeoff time to meet your TOT without modifying preplanned flight parameters. Allow for the possibilities of being delayed or getting to the start point early. An early arrival may necessitate holding at the entry point, if allowed.

9.17.2. Timing and Airspeed Errors. Low-level route timing is dependent upon flying a precise GS for a precise amount of time. An inaccurately planned IAS (this is, not corrected for temperature, pressure altitude, or wind) or poor throttle control will almost certainly result in timing errors. Timing errors are further complicated by poor airspeed control when climbing, descending, and turning. For example, if your airspeed and/or bank angles during turns are not as planned, the turn radius (and thus, the timing) will be different. Additionally, timing errors are further complicated by incorrect map-reading and/or the use of poorly defined landmarks for timing references.

9.17.3. Timing Corrections. There are two basic methods of correcting elapsed time errors on a low-level mission—changing the airspeed and changing the route of flight. The following subparagraphs indicate several methods of airspeed correction:

9.17.3.1. Airspeed Correction—10-Percent Method. This method is based on the approximation that a 10 percent increase or decrease of GS, held for 10 minutes, will gain or lose 1 minute. However, it is not necessary to wait until a 1-minute error exists because the time error (in fractions of a minute) is directly proportional to the duration of the speed change. The calculations for the 10-percent method are as follows:

9.17.3.1.1. 10 percent of GS = GS factor.

9.17.3.1.2. GS ± GS factor = corrected GS.

9.17.3.1.3. Maintain corrected GS for [number of seconds early or late x 10] seconds.

9.17.3.2. Airspeed Correction—Incremental Method. In the incremental method of time control, airspeed in miles per minute is used to determine the speed change. To obtain nm per minute, divide your planned GS by a factor of 60. At 360 knots GS, you are traveling at 6 nm per minute; at 420 KIAS, you are traveling at 7 nm per minute. To determine the speed change increment, multiply the nm per minute by a factor of 10 (for example: 6 nm per minute x 10 = 60 knots). Maintain corrected GS (GS ± the speed change increment) for 1 minute for every 10 seconds early or late.

9.17.3.3. Airspeed Correction—Proportional Method. This method is simple and closely resembles the incremental method. For each second early or late, increase or decrease IAS by 1 knot for the number of minutes equal to the GS in nms per minute. For example, if you are on a 360 knots GS route (6 nm per minute) and 10 seconds early, decrease airspeed by 10 knots and hold that correction for 6 minutes.

9.17.3.4. Airspeed Correction—Next-Leg Method. This method of timing correction is simple and particularly useful to single-seat pilots. Airspeed (in nm per minute) is used to determine the speed change increment (in GS). First, determine the number of seconds early or late. Divide this by the time (in minutes) for the next leg of the low-level route. Multiply the dividend by the nm per minute. The result is the GS correction. Add or subtract the GS correction to the original cruise airspeed. Fly the corrected GS for the entire next leg. For example, if you are on a 360 knot GS route and 20 seconds late at the IP, the IP to target is 2 minutes and 40 seconds. Increase airspeed by 45 knots and hold the correction for the entire IP-to-target leg.

9.17.3.5. Airspeed Correction—Leg Correction (Thorton Method):

9.17.3.5.1. Derived from the proportional and next-leg methods, the Thorton method uses a time or distance increment and the next-leg time or distance (either one works) to establish a correction factor for each leg. The time/distance increment is that time or distance at which the proportional method would result in a one-to-one relationship between speed change and seconds early or late. (For example, at 360 knots planned GS, the time or distance increment is 6 min/36 nm. This is because using the proportional method when you are 10 seconds early or late would result in a 10-knot correction held for 6 min/36 nm. At 420 knots planned GS, the time/distance increment is 7 min/49 nm).

9.17.3.5.2. When planning to use this technique, it is best to calculate the correction factor during the planning stage and annotate it on the low-level map. To calculate the correction factor, take the time/distance increment and divide it by the next-leg time/distance. For example, dividing the time/distance increment (6 min/36 nm) by the next-leg time/distance (4 min/24 nm), 6 min/4 min or 36 nm/24 nm yields a leg correction factor of 1.5. Write that correction factor on the low-level map next to that leg. When airborne, determine your timing deviation in seconds and multiply it times your leg correction factor. Apply that correction for the entire next leg. For example, 10 seconds late times the correction factor of 1.5 yields a correction of 15 knots, so fly 15 knots faster for the entire leg.

9.17.3.6. Airspeed Correction—Ground Track Method. This method is viable only when prominent ground features are used as turn points. If you are within 10 seconds early or late, plan to make the next turn point prior to or just after the desired turn point. Remember to add an additional ground track correction to return to the planned routing and consider the time required for route correction. This technique is heavily based on TLAR (That Looks About Right), but can be used effectively to adjust timing and minimize task saturation.

9.18. Turn Point Techniques:

9.18.1. Approaching the Turn Point. Accomplish administrative tasks early to avoid multiple cockpit tasks when doing high bank turns at low altitude. Determine the direction of turn and the desired new heading. (Many pilots like to put the heading marker on the next heading.) If you approach the turn point from a ground track other than the one on the map, realize that your preplanned turn to the next leg must be altered to put you back on track. Check outside references to visualize the approximate amount of turn required.

9.18.2. At the Turn Point. Cross-check time at (or abeam, if not directly overflying) the turn point to confirm overall elapsed time or real-world time. Make necessary adjustments after rolling out of the turn. If rehacking at each turn point for DR, rehack just prior to starting the turn.

9.18.3. Making the Turn:

9.18.3.1. Low altitude turns make up 5 percent of low-level flying, but they account for 52 percent of all low-level accidents. Turn to the next leg when directly over the turn point, using the bank angle and G-loading your planned ground track and timing are based on. If you do not visually acquire the turn point, turn on time. **Note:** Use caution when making turns at low altitude because sink rates can quickly develop if you overbank and there will be little time or altitude with which to recover.

9.18.3.2. In the turn, 100 percent of your attention should be focused on making the turn until you have rolled out, wings level. Make the turn, maximizing outside references. Place the pitot tube on the horizon, roll, and pull to maintain a level turn. If you detect a descent, immediately roll out of the turn and climb back to a minimum of the altitude you had at the beginning of the turn. If you detect a climb, control the bank to arrest the climb, but do not attempt to descend back to 500 feet. It is critical that you clear throughout the maneuver. While in a turn, clear from the top of the canopy to the pitot tube, until you approach the outside reference point for rolling out on course. If you've misjudged the turn, make a correction after rolling wings level and referencing the HSI.

9.18.4. Bank Angle and G-Loading. **Table 9.1** shows the Gs required to maintain coordinated level flight at higher bank angles and your time to impact from 500 feet AGL at various overbank or G conditions at any airspeed.

Table 9.1. Time to Impact (Overbank From 500 Feet AGL).

I	A	B	C	D
ITEM	**Bank Angle**	**Gs Required**	**Undetected Overbank**	**Time to Impact**
1	60 degrees	2 G	70 degrees/2 G	9.9 seconds
2	70 degrees	approximately 3 G	80 degrees/3 G	8.1 seconds
3	75 degrees	approximately 4 G	85 degrees/4 G	6.9 seconds
4	80 degrees	approximately 6 G	90 degrees/6 G	5.6 seconds

9.18.5. **Effect of Undetected Descent—Time to Impact.** **Table 9.2** shows your time to impact from 500 feet AGL at various dive angles and a speed of 360 KIAS. **Note:** Any bank angles greatly shorten the time to impact.

Table 9.2. Time to Impact (Attitude From 500 Feet AGL).

I T E M	A Attitude	B Time to Impact
1	2 degrees	approximately 25 seconds
2	5 degrees	approximately 10 seconds
3	10 degrees	approximately 5 seconds

9.19. Approaching the IP or Target Area. Strive to fly over the IP as close as possible to your planned time. Make any small corrections to timing early to prevent large airspeed corrections later. Depart the IP on planned heading and airspeed. Deviate only as necessary to react to threats (birds, aircraft, other obstacles). Everything that takes place in the target area is critical. In fact, you should have most of the IP-to-target run memorized so you are not heads down in the cockpit trying to pick up references from the map.

9.20. Route Exit:

9.20.1. Give the return route leg the same emphasis as the entry leg. If your target is not at (or near) your route exit point, you may need to preplan an off-target point to start route egress.

9.20.2. Once you are clear of the MTR, you are no longer in the low-level structure and are, therefore, limited to 300 KIAS below 10,000 MSL. Consequently, a route exit almost always calls for an immediate climb, during which you can trade airspeed for altitude.

9.20.3. Whether you are returning IFR or VFR, you will need to coordinate arrival with ATC. When exiting a VR, maintain VFR conditions until you have an IFR clearance. Continue on your IFR clearance when exiting an IR.

9.21. Abnormal Procedures:

9.21.1. Single-Ship, Low-Level Problems and Emergencies. Every low-level emergency, including encountering IMC, requires a climb to a safe AGL altitude. Climb-to-cope is a common phrase to describe your initial action when faced with a problem at low altitude. You must put the aircraft into a position where you can safely analyze the situation and coordinate your recovery with outside agencies.

9.21.2. Without Radio Contact. If you cannot contact a controlling agency while airborne, follow the local lost-communications procedures, specific route lost-communications procedures (listed in FLIP AP/1B), or general lost-communications procedures in the FIH. If you have maintained positional awareness and are able, proceed to your home base or the nearest suitable airfield, as appropriate, while handling the problem.

9.21.3. IMC Route Abort:

9.21.3.1. When it becomes obvious you cannot continue the route without going IMC, abort the route. If possible, turn as necessary to remain VFR. If you cannot avoid IMC while flying a low-level route, immediately abort the route and climb on course to the RAA as a minimum. Make an expeditious climb, using MIL power and a maximum of 300 KIAS. High terrain may require the use of afterburner in some instances. In all cases, immediately establish a climb on course. Do not, under any circumstances, attempt to reenter the low-level route after initiating an abort. Route aborts are potentially disorienting and require an immediate transition to instruments and close attention to aircraft control and flight parameters.

9.21.3.2. Once you are level at or above the RAA, squawk "emergency" as appropriate and coordinate for an IFR clearance to your destination airfield. Because the RAA only provides obstacle clearance within 5 nm of the route, the recovery to your destination may require a higher altitude to ensure obstruction clearance.

9.21.4. Lost Procedures. If you miss consecutive checkpoints or turn points, do not recognize any references from your map, or are unable to reorient yourself, abort the route and follow the VFR lost procedures in **Chapter 8.9**.

Section 9E—Low-Level Formations

9.22. Two-Ship, Low-Level Navigation. A successful two-ship, low-level mission is the culmination of all your navigation and formation training to this point, requiring a combination of solid low-level practices, formation skills, and discipline.

9.23. Preflight Planning. Preflight planning for a two-ship, low-level mission is usually more involved than either a single-ship, low-level mission or a standard two-ship formation mission. The major addition in the planning process is that you are effectively drawing two parallel black line routes 1 mile apart. This may require altering the choice of turn points to ensure the formation stays in the corridor, avoids obstacles, and adjusts for significant terrain changes. It is possible to use a preexisting low-level planned for a single-ship mission. However, extra time should be spent during the route study and briefing phases to ensure all formation members are aware of where the wingman should fly to comply with the considerations above.

9.24. Types of Low-Level Formations:

9.24.1. Tactical Line Abreast. When flying over relatively level terrain, the line-abreast formation can work well. The same parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead. Consider using the air-to-air TACAN to help gauge the 4,000to 6,000-foot distance. Low-level flying introduces some additional visual cues and takes time to visually calibrate the proper distance.

9.24.2. Wedge. When substantial maneuvering is required or while you are over terrain with vertical development, wedge formation may be a better choice than line-abreast tactical. It gives the wingman the flexibility to alter sides as necessary and may lessen lead's saturation in ensuring the wingman is on the proper side. The parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead.

9.24.3. Fighting Wing. When a clearing formation is needed or aggressive maneuvering is required, fighting wing may be flown. The same parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead.

9.25. Departure. In addition to managing normal formation responsibilities, lead must navigate to the start point and accomplish all other low-level entry requirements for the particular MTR. To enhance clearing and increase the formation's maneuverability, spread the wingman to route, fighting wing, or tactical formation as soon as possible after takeoff. Unless weather or other procedures dictate, maintain a clearing formation to the route entry.

9.26. Route Entry. If not already accomplished, lead will put the wingman in fighting wing, wedge, or another formation suitable for visual lookout and maneuverability prior to route entry. In a relatively short span of time, lead must call "entering the route," locate the entry point, maneuver the formation as necessary for course alignment, call the time hack over the radio, and accelerate to the planned IAS. Prior planning and solid SA are imperative for a smooth entry into the low-level structure.

9.27. Low-Level "Contract" and Priorities as Lead:

9.27.1. Do Not Hit the Ground or Anything Attached to It. As much as possible, position the wingman on the side opposite high terrain features or known obstacles. Climb the formation in sufficient time to avoid all obstacles within 2 nm of your planned ground track unless you are able to visually acquire and ensure lateral separation from obstacles along the flightpath of the entire formation. Call out any obstacles (towers, etc.) that could be a factor to the formation. Direct the wingman to climb if he or she is flying lower than he or she should.

9.27.2. Maintain Excellent Visual Lookout. Find, call out, and avoid any traffic or birds that could be a factor to the formation. Avoid conflicts and potential midair collision situations with the wingman.

9.27.3. Communications and Brevity Code. Use standard brevity code when referring to objects or positions on the ground. Unless lead briefs otherwise, formations will use the following plan to communicate whether or not obstacles are in sight. The flight member sighting the obstacle transmits his or her call sign and the clock position of the obstacle relative to one of the other flight member's nose position (for example, Mach 2, tower, off your nose, 1 o'clock 4 miles."). The other flight member acknowledges (for example, "Mach 1, contact" or "Mach 1, negative contact.").

9.27.4. Navigate and Lead. Use single-ship low-level route and timing corrections to fly the route, identify all turn points, and be in a position to arrive at the target on time. In addition to single-ship techniques, you will probably need to incorporate formation check turns, tactical turns, and shackles. Climb the formation for all avoidance areas either you or your wingman will penetrate. Accomplish all turns as briefed and, unless called otherwise, roll out of each turn on the heading for the next leg.

9.27.5. Maintain SA on the Wingman. Stay visual, direct formation adjustments as necessary, and stay aware of the wingman's fuel state. Initiate ops checks at appropriate intervals (every 10 minutes or every other leg, as a minimum).

9.28. Low-Level "Contract" and Priorities as the Wingman:

9.28.1. Do Not Hit the Ground or Anything Attached to It. Climb in sufficient time to avoid all obstacles within 2 nm of your ground track unless you are able to visually acquire and ensure lateral separation from them. Call out any obstacles (towers, etc.) that could be a factor to the formation.

9.28.2. Maintain Excellent Visual Lookout. Find, call out, and avoid any traffic or birds that could be a factor to the formation. Avoid conflicts and potential midair collision situations with lead and, of course, stay visual—do not go blind!

9.28.3. Fly the Prebriefed or Directed Formation Position. Always strive for the prebriefed formation position unless turn requirements or safety dictate otherwise. In tactical line-abreast or wedge formations, stack level to slightly high. At 500 feet AGL, lead will be on the horizon to very slightly above the horizon when you are stacked level at 6,000 feet laterally. Whenever a flightpath conflict with lead exists, cross high in relation to lead.

9.28.4. Maintain SA on Navigation, Route, and Timing. Strive to maintain sufficient positional awareness so you know when to expect key events such as turns, climbs, and position changes. Unless called otherwise, roll out of each turn on the planned heading for the next leg. Strive to maintain enough SA to confidently assume the lead if necessary.

9.29. Low-Level Turns as Lead:

9.29.1. Wingman on the Inside of the Turn. Begin your contract turn over the planned turn point to keep your aircraft on the planned ground track. Unless briefed otherwise, the wingman should climb to deconflict, if necessary.

9.29.2. Wingman on the Outside of the Turn. From tactical line abreast, start the wingman turning early enough to allow you to delay your turn until right over the planned turn point. A turn of 90 degrees will require a lead point of 1 nm, a turn of 45 degrees will require a lead point of 1/2 to 3/4 nm, and a turn of more than 90 degrees will require a lead point of more than 1 nm. For a 90or 45-degree turn, use the references described in **Chapter 6** for tactical turns. For a turn of greater than 90 degrees, turn sooner than the 90-degree turn reference.

9.29.3. Turns of 30 Degrees or Less. Normally, you can simply turn to the new heading; a delayed turn is not necessary. For a planned check turn into the wingman, brief him or her to drop back closer to the 30-degree line before the turn. Depending on the formation at the time, it will always be your option to direct an unplanned check or tactical turn.

9.29.4. Misjudging a Tactical Turn. If you misjudge a lead point or are late visually acquiring a turn point, do not significantly delay your turn by waiting for the wingman to turn the appropriate number of degrees. This may adversely affect your DR and could possibly result in a loss of SA.

9.30. Low-Level Turns as the Wingman:

9.30.1. Wingman on the Inside of the Turn. Delay your turn until lead has turned an appropriate number of degrees to allow you to complete the turn in the proper tactical position. For a turn of 90 or 45 degrees, use the same references as a turn in the MOA. For a turn of greater than 90 degrees, turn sooner than the 90-degree turn reference. If you misjudge your turn, vary your power and/or G-loading to compensate and regain proper tactical position. Unless briefed otherwise, climb to deconflict if necessary.

9.30.2. Wingman on the Outside of the Turn. Anticipate the turn and the call or signal from lead. Have the rollout heading in mind, execute a contract turn, and climb to deconflict if necessary.

9.31. Low-Level Position Changes. Accomplish position change by following the guidance in **Chapter 6**.

9.32. Lost Sight Situations:

9.32.1. When Wingman Loses Sight. During low-level tactical turns, you may momentarily lose sight of lead. This is acceptable as long as you regain sight of lead at an appropriate time. However, if you do not regain sight at an appropriate time or if you unexpectedly lose sight at any other time, transmit your call sign along with "blind." Maintain your current heading and climb to 1,000 feet AGL to help ensure deconfliction and terrain clearance while you search for lead. If you regain sight of lead, call "visual" and continue the mission. However, if you are unable to regain sight of lead after the climb, continue to ensure terrain clearance and follow lead's instructions.

9.32.2. Lead Actions When Wingman Loses Sight:

9.32.2.1. If the wingman calls "blind" and you have him or her in sight, start a climb to 1,000 feet AGL and transmit your call sign, the word "visual," and your relative position. If the wingman visually acquires you in the climb, you may descend back to 500 feet AGL.

9.32.2.2. If the wingman is still unable to visually acquire you, direct him or her to maintain or pick up an appropriate altitude and heading. Consider a moderate, controlled wing rock, but guard against excessive maneuvering that could lead to disorientation. If necessary, rejoin on the wingman while talking his or her eyes onto you. Rejoin to no closer than 500 feet if the wingman is still blind. Once the wingman has you visually, direct him or her to an appropriate formation position and continue the route if conditions and corridor boundaries allow.

9.32.3. A "Double-Blind" Situation—Wingman and Lead Both Lose Sight:

9.32.3.1. If the wingman calls "blind" and you, as lead, do not have him or her in sight, maintain your current heading and direct the wingman to maintain the same heading. Begin a climb to 1,000 feet AGL and direct the wingman to climb to 1,500 feet AGL.

9.32.3.2. If both aircraft regain sight of each other in the climb, lead may descend back to 500 feet AGL and continue the mission. If lead visually acquires the wingman in the climb, both will follow the procedures in the preceding paragraph. If neither aircraft regains sight, both will continue to the next turn point, using landmarks along the route to try to find each other. When arriving at the next turn point, do not continue the route as a formation past this point.

9.32.3.3. Consider using air-to-air TACAN. Be aware of the fuel remaining, the aircraft scheduled after you on the low level, and how much time can be spent attempting to get back together. Relay your position to the wingman, using a timing reference or landmark along the route.

9.32.3.4. Normally, lead and the wingman will both abort the low-level route. Once they climb out of route, they do not reenter the MTR. If still unable to regain sight of each other, they will accomplish single-ship recoveries. During single-ship recoveries, lead will ensure altitude separation from the wingman until confirming radar contact with a controlling agency.

9.33. Radio Failure:

9.33.1. Lead Loses Radio. Accomplish all radio failure cockpit and equipment checks. If radio failure is confirmed or strongly suspected, climb to a minimum of 1,000 feet AGL and rejoin the wingman. Once rejoined, give the appropriate AFPAM 11-205 visual signals and follow the briefed no radio (NORDO) procedures. If you notice the wingman flying at 1,000 feet AGL and rocking the wings, climb to at least 1,000 feet AGL and have the wingman rejoin. After you receive and acknowledge the wingman's visual signals, follow the briefed procedures.

9.33.2. Wingman Loses Radio. Accomplish radio failure cockpit and equipment checks. If radio failure is confirmed or strongly suspected, climb to 1,000 feet AGL and rock the aircraft's wings to get lead's attention. However, do not sacrifice aircraft control in an attempt to gain lead's attention and do not close to within 500 feet of lead until given the proper signal. Once rejoined, give the appropriate AFPAM 11-205 visual signals for your situation.

9.34. IMC Route Abort:

9.34.1. Lead Actions:

9.34.1.1. When possible, avoid IMC by climbing or turning. Use an in-place turn if necessary. If IMC penetration is imminent, attempt to rejoin the wingman while maintaining VMC. If unable to maintain VMC until the wingman is rejoined, ensure the flight initiates a wings-level climb to the RAA minimum with the required altitude separation. This will allow the wingman to stay above you.

9.34.1.2. Ensure the wingman is paralleling your heading and squawk "emergency" on the IFF/ SIF as soon as practical. To lessen the chances of a midair collision with the wingman, do not turn while in IMC.

9.34.1.3. If unable to reach VMC above the RAA, ensure altitude separation with the wingman and attempt to contact a radar facility. If you are unable to contact a radar facility, climb to a higher altitude while still ensuring altitude separation with the wingman. Continue to climb, and squawk "emergency" until reaching VMC or contacting a radar facility.

9.34.2. Wingman Actions. When directed, rejoin as expeditiously as possible without becoming a hazard to the formation. If you are unable to rejoin prior to entering IMC, make a slight turn away from lead until ensuring altitude separation. Then parallel lead's heading and follow his or her instructions.

Chapter 10

NIGHT FLYING

10.1. Ground Operations:

10.1.1. Mission Briefing. In addition to normal briefing items, night flying requires discussing, in detail, the lighting (cockpit, aircraft, airfield, environment), taxi spacing and distance, radio procedures, alternate or emergency airfields, and a host of other items that, during day operations, are simply considered standard. Even something as simple as filling out a lineup card in black ink will ease task accomplishment at night.

10.1.2. Preflight Power. Use external power, if available, to thoroughly check all aircraft lighting (interior and exterior) including the map light. Ensure the marshaller has two illuminated wands.

10.1.3. Interior Inspection and After Start. During the interior inspection, dim the marker beacon and AOA indexer lights. In addition, rotate the three lighting rheostats on the right console out of the OFF position. After starting the right engine and if not using external power, check all interior lights. Adjust the lighting rheostats to the lowest practical setting and dim the caution, warning, and indicator lights to avoid excessive cockpit reflection or glare. Position the map or utility light as desired and consider selecting the red lens on it and your flashlight.

10.1.4. Before Taxi. If adequate airfield lighting exists, delay turning on the landing light until you are out of the chocks to avoid blinding the crew chiefs. Because the rotating beacon may hinder maintenance personnel while they are under the aircraft, consider turning it off.

10.1.5. Taxi. Remain on the yellow lines and taxi slower because speeds and distances are deceptive during night operations. Solo students should accomplish all checklist items while stopped.

10.2. Single-Ship Takeoff. Line up on the runway centerline and recheck the ADI and HSI. After runup checks and brake release, use the composite method of aircraft control you learned during day contact flying. Remain oriented to the instrument references as well as outside objects to minimize the chance of spatial disorientation. Certain weather conditions or a lack of visual cues may necessitate a complete transition to flight instruments immediately after takeoff. The rate of transition to instruments should correspond with the rate at which outside references fade. Ensure the aircraft is safely airborne before raising the landing gear handle and be aware that the retracting landing light can give a false sensation of increasing pitch.

10.3. Use of Night Visual References:

10.3.1. Visual references and depth perception change with night operations. To overcome the decrease in visual cues, use instruments to a greater extent. Throughout the sortie, continue to adjust cockpit lighting to maximize your night vision, decrease glare, and minimize reflections.

10.3.2. At night, lighted objects often appear closer than they actually are. Because altitude and rate of descent are more difficult to judge close to the ground, rely more on the altimeter and VVI than on visual perception. Cross-check the ADI to determine the proper aircraft attitude when no definite horizon exists.

10.3.3. Although there is an increased emphasis on flight instruments at night, visual references are still a primary means of orientation during night VMC operations. However, if you detect an unusual attitude or feel the effects of spatial disorientation, immediately make a transition to flight instruments and recover.

10.4. Depth Perception. Use caution when descending for the initial traffic entry at night because height above the ground is difficult to judge. Closely check the altimeter during night operations to ensure a proper interpretation. Misreading the altimeter by 1,000 feet is slightly more common at night and can be disastrous. Proper interpretation and use of the altimeter's pointer, counters, and low-altitude crosshatch marks are critical for safe night operations.

10.5. Optical Illusions at Night. Use caution when flying approaches, especially to a strange field. Sloping or featureless terrain, sloping runways, varying runway widths, runway lighting intensity, and/or weather phenomena can cause visual illusions at night. One of the best defenses against illusions at a strange field is thorough preparation. Study the airfield and approach diagrams and become thoroughly familiar with its lighting and glidepath guidance systems.

10.6. Visual and Instrument Straight-In Approaches. Whether practicing visual or instrument straight-in approaches at night, approach control will provide positive radar control for pattern spacing and sequencing to final. Do not rely entirely on visual cues. Use composite flight references, to include glidepath, course, and lighting system guidance.

10.7. Overhead Patterns:

10.7.1. Clearing. The night pattern can get very busy so it is critical to clear visually and on the radios. It is difficult to tell whether an aircraft is turning crosswind or pulling closed. Listening carefully to the radio call will help you know aircraft position and intention. If in doubt, turn crosswind, carry straight through initial, or break out, as applicable.

10.7.2. Pattern Entry and Break. Clear and complete the entry and turn onto initial or radar initial the same as during daylight operations. Because you may not see the runway clearly, initiate the break by referring to the ramp or other lighted areas on the field. Initiating the break with traffic abeam you will ensure 6,000 feet of runway separation. Continue to use a composite cross-check during the break to maintain aircraft control.

10.7.3. Final Turn and Final. Fly the turn to final and final approach, using a composite cross-check, because some visual cues will be hard to see (for example, a horizon). A good technique is to emphasize being on airspeed at desired altitudes for the perch, halfway through the final turn, and especially rolling out on final.

10.7.4. Transition to Landing and Landing. For night training, many pilots prefer to use the runway threshold lights for the aim point instead of the middle of the overrun. This technique should minimize overrun landing situations, but will lead to longer landings. Long, fast landings at night are especially dangerous because many of the daytime runway's cues may not be available. As you approach the overrun, the landing light will illuminate the surface of the overrun and runway, helping with depth perception. Do not use runway lights as the only reference to judge height above the runway because they can lead to a high flare and dropped-in landing. Plan to land on the runway centerline.

10.8. Night Formation:

10.8.1. Mission Briefing. In addition to normal briefing items, emphasize visual signals, radio procedures, crew coordination, spatial disorientation, and lost wingman procedures.

10.8.2. Takeoff:

10.8.2.1. Lead. In addition to winds, etc., consider the location of ramp lights when positioning a wingman for a night takeoff. As you take the runway, dim the position lights and turn off the rotating beacon. Normally, unless specified in unit standards, replace the daylight visual signals with radio calls for engine runup, brake release, and gear retraction. When lighting conditions permit, brief visual signals.

10.8.2.2. Wingman. Your position lights should remain bright and your rotating beacon on.

10.8.3. In Flight:

10.8.3.1. Lead. Based on weather, natural lighting, visible horizon, and available ground references, use basically the same wingman considerations during night formation maneuvering as during day IMC maneuvering. Depending on proficiency, slower roll rates may be preferred.

10.8.3.2. Wingman. To maintain the normal fingertip position at night, cross-check references more often than during the day. Do not stare at any one light on lead's aircraft because this may result in a loss of depth perception. When you are in fingertip position, your rotating beacon will reflect off lead's aircraft and help your depth perception. If you fall low, you will lose that effect.

10.8.3.3. Route. Because of reduced visual cues, flying route at two to three ship widths and forward of the wing line will maximize the illumination effect of the rotating beacon. During turns into the wingman, Number 2's beacon will illuminate lead. During turns away, this effect is lost. Under certain conditions (little moon illumination, poor horizon, haze), consider reforming Number 2 into fingertip before a turnaway.

10.8.3.4. Crossunder. Crossunders may be initiated with a visual signal or radio call. Make all control inputs smooth and deliberate. Crossunders should take a little longer at night due to reduced visual cues.

10.8.3.5. Formation Approach. Normally, lead will call gear extension and retraction over the radio. If the wingman's landing light becomes a distraction, lead should direct him or her to turn it off. Consider using 60 percent flaps to help save fuel. A radio call or zipper may be used to initiate a go-around from the low approach.

10.8.3.6. Position Change. Night position changes will be made over the radio. The aircraft assuming the lead should dim the position lights and turn off the beacon. The aircraft assuming the Number 2 position should do the opposite.

10.8.3.7. Night Overhead Traffic Pattern Splitup. As soon as practical after the splitup, lead will turn on the rotating beacon and return the position lights to the bright setting. Normally, the wingman should delay the break for about 8 seconds to build 6,000 feet of spacing behind lead.

JOSEPH T. GUASTELLA Jr., Lt Gen, USAF
Deputy Chief of Staff, Operations

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

FAA Order JO 7610.4 V, *Special Operations-*Non FAA Employees*, 5 July 2019

FAA Order JO 7110.67K, *Air Traffic Management Security for Special Operations*, 1 October 2019

FAA Order JO 7110.67K, *Air Traffic Management Security Services for Special Operations *Non-FAA Employees,* 1 October 2019

AFI 11-200, *Aircrew Training, Standardization/Evaluation, and General Operations Structures*, 21 September 2018

AFMAN 11-2T-38, Volume 1, *T-38 Aircrew Training*, 14 May 2020

AFMAN 11-2T-38, Volume 2, *T-38 Aircrew Evaluation Criteria*, 14 May 2020

AFMAN 11-2T-38, Volume 3, *T-38 Operations Procedures*, 14 May 2020

AFMAN 11-202, Volume 3, *Flight Operations*, 10 January 2022

AFPAM 11-205, *Aircrew Quick Reference to Aircraft Cockpit and Formation Flight Signals*, 09 August 2018

AFI 11-214, *Air Operations Rules and Procedures*, 08 July 2020

AFMAN 11-218, *Aircraft Operations and Movement on the Ground*, 05 April 2019

AFPAM 11-419, *G Awareness for Aircrew*, 17 October 2014

AFI 33-322, *Records Management and Information Governance Program*, 23 March 2020

DAFMAN 90-161, *Publishing Processes and Proceedures*, 15 April 2022

DAFMAN 11-401, *Aviation Management*, 27 October 2020

Air Force Records Information Management System

Records Disposition Schedule

Flight Information Publications (FLIP) General Planning (GP)

Flight Information Handbook (FIH) General Planning (GP) AP/1B Manuals

TO 1T-38A-1, *Flight Manual USAF Series T-38 Aircraft* (referred to as the flight manual), 15 July 2011

TO 1T-38A-1CL-1, *Pilot's Abbreviated Flight Crew Checklist*, 01 April 2019

Adopted Form

AF Form 847, *Recommendation for Change of Publication*

AFTO Form 781, *ARMS Aircrew/Mission Flight Data Document*

AF Form 70, *Pilot's Flight Plan and Flight Log*

DD Form 175, *Military Flight Plan*

DD Form 1801, *DoD Military Flight Plan*

Abbreviations and Acronyms

AC—aircraft commander

ACC—Air Combat Command

ACC/A3TO—ACC Flight Operations Training Branch

ADI—attitude director indicator

AFI—Air Force Instruction

AFMAN—Air Force Manual

AFTO—Air Force Technical Order (Used for forms e.g., AFTO Form 781)

AGL—above ground level

AOA—angle of attack

ARTCC—air route traffic control center

ATC—air traffic control

ATIS—automated terminal information service

BD—battle damage

BFM—basic fighter maneuver

CDI—course deviation indicator

CHUM—chart update manual

CSW—course select window

DAFI—Department of the Air Force Instruction

DME—distance measuring equipment

DR—dead reckoning

EGT—exhaust gas temperature

EOR—end of runway

ET—Extended Trail

FAA—Federal Aviation Administration

FAF—final approach fix

FBO—flight base operator

FENCE—Fire control, Emitters, NAVAIDs, Communications, and Electronic countermeasures

FIH—Flight Information Handbook

FL—flight level

FLIP—Flight Information Publications

FLOLS—Fresnel Lens Optical Landing System

FM—fluid maneuvering

FOD—foreign object damage

fpm—feet per minute

FSS—flight service station

GP—General Planning

GS—ground speed

HCA—heading crossing angle

HSI—horizontal situation indicator

IAF—initial approach fix

IAS—indicated airspeed

IAW—in accordance with

IFF/SIF—identification, friend or foe/selective identification feature

IFR—instrument flight rules

ILS—instrument landing system

IMC—instrument meteorological conditions

IMN—indicated Mach number

IP—instructor pilot or initial point

IR—instrument route

ITO—instrument takeoff

JOG—joint operations graphic

KIAS—knots indicated airspeed

LAB—Line Abreast

LOS—line of sight

MACS—minimum acceleration check speed

MAX—maximum afterburner

MDA—minimum descent altitude

MIL—military (power)

MOA—military operations area

MSL—mean sea level

MTR—military training route

NAVAID—navigational aid

nm—nautical mile

NORDO—No Radio

NOTAM—notice to airman

ONC—operational navigation chart

OPR—Office of Primary Responsibility

PAPI—precision approach path indicator

PAR—precision approach radar

PIC—Pilot in Command

PIO—pilot-induced oscillation

PIREP—pilot report

PIT—Pilot Instructor Training

PMSV—pilot to metro service

POM—plane of motion

pph/engine—pounds per hour per engine

PVASI—Pulsating Visual Approach Slope Indicator

RAA—route abort altitude

rpm—revolutions per minute

RSU—runway supervisory unit

RTB—return to base

SA—situational awareness

SETOS—single-engine takeoff speed

SID—Standard Instrument Departure

SII—special interest items

SOF—supervisor of flying

SR—slow route

STAR—Standard Terminal Arrival Routes

SUP—Supervisor

SUPT—Specialized Undergraduate Pilot Training

TACAN—tactical air navigation

TO—Technical Order

TOLD—takeoff and landing data

TOT—time over target

TPC—tactical pilotage chart

VASI—visual approach slope indicator

VDP—visual descent point

VFR—visual flight rules

VHF—very high frequency

VMC—visual meteorological conditions

VR—visual route

VVI—vertical velocity indicator

Terms

3/9 Line—An imaginary line extending through the 3and 9-o'clock positions of an aircraft (also known as the pitch or lateral axis).

Abort—Directive to cease the action, attack, event, or mission.

Acceleration maneuver—A maneuver flown to increase airspeed. Zero G is optimum.

Admin lead—Used to pass lead responsibilities to another member of the flight. The administrative (admin) lead is expected to run all aspects of the profile to include navigating, managing the radios, and making changes to the profile if external conditions dictate (for example, changing the bingo fuel with a change in the alternate). With an admin lead change, the call signs within the flight are administratively renumbered to match the position being flown. Lead still retains ultimate authority for the formation.

Angle-off—The angle formed by the extension of the longitudinal axes of two aircraft; the difference in headings. Also called the heading crossing angle (HCA).

Aspect Angle—The angle measured from the tail or longitudinal axis of one aircraft to another aircraft's position. For example, 0 degrees aspect angle is directly behind and 180 degrees aspect angle is directly in front. The aspect angle is independent of the other aircraft's heading.

Bingo—A prebriefed fuel state needed for recovery using prebriefed parameters.

Blind—No visual contact with friendly aircraft; the opposite of "visual."

Break (Up, Down, Right, or Left)—To perform an immediate maximum performance turn in the indicated direction. Assumes a defensive situation.

Cleared—Requested action is authorized.

Closure—Overtake created by airspeed advantage and/or angles. The rate at which range decreases (also known as VC: closure velocity "V-sub-C"). Closure can be positive (getting closer) or negative (getting farther away).

Cross turn—A 180-degree heading reversal by a flight where aircraft turn into each other.

Divert—Proceed to alternate mission or base.

Element lead—The pilot responsible for the conduct of a two-ship element. In a two-ship formation, the element lead is the flight lead (see definition). Number 3 is the element lead in a four-ship formation. (Normally, one wingman should not fly formation off of another wingman.)

Extension or acceleration maneuver—An unloaded maneuver, almost always at a high-power setting, to gain airspeed and either generate closure (decrease distance) or increase opening velocity (separation).

FENCE—The boundary separating hostile and friendly areas. Entering or exiting designated area.

FENCE check—Set cockpit switches as appropriate.

Flight lead—Although perhaps not the most experienced pilot in the flight, the flight lead (referred to as "lead") is charged with the safe and successful completion of the mission. Wingmen may lead portions of the mission, but the designated flight lead does not change.

G-Awareness Exercise—High G turns to check aircraft and pilot readiness to pull Gs when over 4 Gs are anticipated during the sortie. 1st turn sustains 4 Gs, the second sustains 5 Gs.

High six—A position physically above and behind an aircraft regardless of heading or bank angle.

Joker—Fuel state above bingo at which separation, bug out, or event termination should begin and proceed with the remainder of the mission.

Knock-it-off—Training term used to stop maneuvers in progress for safety of flight issues.

Lag pursuit—Maneuvering to control closure, range, and/or aspect angle by positioning the lift vector (or flightpath) toward the outside of another aircraft's turn circle. Lag pursuit usually decreases aspect angle.

Lag reposition—An out-of-plane maneuver performed to control overtake, decrease aspect angle, and/or prevent an overshoot by using vertical turning room above and behind another aircraft's POM.

Lead pursuit—Maneuvering to control closure, range, and/or aspect angle by positioning the lift vector (or flightpath) toward the inside of another aircraft's turn circle. Lead pursuit usually increases or maintains aspect angle.

Lead reposition—An out-of-plane maneuver generally performed to increase overtake and aspect angle and/or decrease range by using vertical turning room below another aircraft's POM.

Lift vector—An imaginary plane going vertically through the top of the aircraft, representing the POM in a straight pull. "Set the lift vector" means to roll the aircraft to set the point you want to pull to at your 12-o'clock high.

Line abreast—Two groups, contacts, formations, or aircraft side by side.

Line of sight (LOS)—A direct line between two aircraft.

LOS rate—Speed of apparent drift of one aircraft in relation to another, speed of angular change of LOS.

Nav lead—May be used when lead wants the wingman to navigate and clear. Lead will fly the wingman position, deconflict within the flight, and keep the radios; for example, battle damage (BD) check.

Ops check—Periodic check of aircraft systems performed by the aircrew (including fuel) for safety of flight.

Overshoot (flightpath)—Results in one aircraft crossing through or behind the flightpath of the other aircraft, but not necessarily in front of the other aircraft's 3/9 line.

Overshoot (3/9 line)—Results in the aft aircraft flushing forward of the other aircraft's 3/9 line.

Perch—A position behind and to the side of an aircraft used to define a starting point for follow-on maneuvering.

Plane of motion—A plane extending from the flightpath of an aircraft to the center of its turn radius. Also referred to as POM.

Pure pursuit—An aircraft with its nose pointing at another aircraft is in "pure pursuit."

Push—Change frequency without acknowledgment.

Quarter plane—A last-ditch maneuver used to prevent a 3/9 overshoot or to "preserve 3/9 line" at closer ranges and higher LOS rates.

Radial G—The vector sum of the aircraft's lift vector and gravity when turning in a vertical POM; that is, the G effectively turning the aircraft.

Shackle—A single crossing of flightpaths; a maneuver to adjust or regain formation parameters.

Squawk ( )—Operate IFF as indicated or IFF is operating as indicated.

Tactical lead—May be used when lead needs the wingman to lead an event (for example, extended trail) or a segment of the flight. In this case, the wingman will pick up tactical, navigation, and radio responsibilities, but not the overall flight lead responsibility. Individual call signs do not change.

Terminate—Training term used to stop maneuvers in progress for nonsafety of flight issues.

Turn circle—The flightpath described by an aircraft in a turn.

Turn radius—The distance between an aircraft's flightpath and the center of the turn circle.

Turn rate—Degrees per second an aircraft turns.

Turning room—Volume of airspace in the vertical, horizontal, or both, which can be used to execute a desired maneuver.

Visual—Sighting of a friendly aircraft or ground position; the opposite of "blind."

Zipper—A double-click of the microphone button used to attract the attention of another pilot in the formation without compromising mission information (for example, call signs or flight composition) or cluttering the frequency.